SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

ROCKY FLATS PLANT SITE

Task 7
of the
Zero-Offsite Water-Discharge Study

Prepared For:

EG&G ROCKY FLATS

Prepared By:

ASI

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ROCKY FLATS PLANT

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Zero-Offsite Water-Discharge Study

Prepared For:

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DISCLAIMER

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EXECUTIVE SUMMARY

The Solar Pond Interceptor Trench System Groundwater Management Study is one of several studies being conducted for, and in the development of, a Zero-Offsite Water-Discharge Plan for the Rocky Flats Plant (RFP) in response to Item C.7 of the Agreement in Principle between the Colorado Department of Health (CDH) and the U.S. Department of Energy (DOE) (ASI, 1990a). Item C.7 describes the Source Reduction and Zero Discharges Study: by requiring a study be conducted "of all available methods to eliminate Rocky Flats discharges to the environment including surface waters and groundwater. This review should include a source reduction review."

Specifically, this report addresses important issues related to the surface water and groundwater management at the Solar Evaporation Ponds. This study assesses possible management alternatives for the contaminated groundwater collected by means of the Interceptor Trench System and transferred to the solar ponds. For purposes of this study, the Interceptor Trench Pump House (ITPH) system is considered to consist of both the interceptor trench itself and the French drain system with which it is associated. This study also included a detailed review of analytical data associated with the groundwater and the quantities of water to be managed (ASI, 1990b). Consideration has been given to the surface water and groundwater quantity and quality in discrete portions of the ITPH system.

Water Quantity

The ITPH is a duplex pump station. The approximate pumping capacities of this station are 80 gallons per minute (gpm) with a single pump operating, and 100 gpm with both pumps operating.

Any incoming flows that exceed 100 gpm will fill the wet-well. Occasionally, the wet well has overflowed, indicating the total capacity of the pump house system is not adequate. Additional pumping capacity should be provided at the station.

The quantity of groundwater transferred to the solar ponds has never been accurately measured; therefore, this study uses the available information to arrive at a best estimate of the actual transferred quantities. The results indicate an average annual quantity of approximately 3,100,000 gallons are transferred to Solar Pond 207B-North. Of this 3,100,000 gallons, it is estimated that as many as 290,000 gallons have been transferred in any two day period. Flows in the various portions of the ITPH system have been measured separately, providing information on the relative magnitude of contribution from the various portions of the system. Of particular importance is the volume of flow, approximately 20% of the overall total (680,000 gallons per year), contributed by the West Collector. This water has different chemical characteristics than the majority of the water collected by the ITPH system. Similarly, some contributions to the overall transferred flow are due to the collection of surface runoff by the ITPH system. This surface runoff may be a relatively clean water that does not require collection and transfer to the solar ponds. It is possible that modifications to the ITPH system could be made in order to reduce the collection of relatively clean flows. Limited data also exist which indicate 4,100,000 gallons of ITPH water were transferred to the solar ponds in one 12-month period.

Water Quality

Water quality analyses of the water transferred by the ITPH system indicate the presence of inorganic constituents (particularly nitrate), radionuclides, and volatile organic compounds. Inorganic constituents and radionuclides are typically present in the general solar pond area and are also present in both groundwater and seepage flows. Volatile organic compounds (VOCs), on the other hand, are predominately contributed by the flows from the West Collector area. The West Collector flows may contribute over half of the total VOCs present in the water transferred by the ITPH system.

Two methods of controlling the quality of the water transferred by the ITPH system are recommended. Separate management of the West Collector flows would reduce the VOC contamination in the water of this system. Use of a production well in the area north of Solar Pond 207B-North, an area in which high inorganic contamination occurs, may improve the groundwater quality downgradient of that area.

Treatment Alternatives

Treatment alternatives for the ITPH system water proposed as a result of this study include: mechanical evaporation; treatment at the Sanitary Treatment Plant; ultraviolet light/peroxide treatment; and reverse osmosis followed by mechanical evaporation. The actual treatment option selected will depend in part upon the results of other studies that are a part of the Zero-Offsite Water-Discharge Study. The final treatment option selected will also depend on the results of the ongoing investigation, characterization, and remediation activities for the solar ponds. These activities are described in the draft Interagency Agreement among the Department of Energy, the Colorado Department of Health, and the Environmental Protection Agency. Relative costs of the four treatment options were estimated based upon the anticipated conceptual design of the facilities. Costs were calculated based solely upon those costs that would be unique for treatment of the ITPH water. For instance, if part of the ITPH flow is to be treated at a treatment plant built as a part of other activities, only the incremental costs of ITPH treatment were assigned to the ITPH evaluation. The capital cost of the treatment facility was expected to be allocated to the project that caused the treatment system to be built. The relative costs of the four treatment options were:

1) mechanical evaporators were the most expensive due to their construction and the additional tanks required specifically for the ITPH water.
2) the sewage treatment plant was the least expensive since only a pump station and a force main are needed for treatment of the ITPH flow at the STP.

3) separate treatment of the water from the west collector from the rest of the ITPH flow is somewhat more expensive than treatment of the entire flow in the STP because two force mains and pump stations must be built.

4) the reverse osmosis/mechanical evaporation option is the second most expensive since a reverse osmosis unit and related tankage will require construction, as well as a force main to Building 374 for treatment of the reject water in the mechanical evaporators.

A matrix was constructed to compare the treatment alternatives with management concerns to best evaluate the treatment alternatives. The preferred treatment options, in order from most desirable to least desirable, are: mechanical evaporation of the entire flow with a score of 337, reverse osmosis and mechanical evaporation with a score of 297, separate treatment with a score of 252, and sewage treatment plant treatment with a score of 230. The treatment options that include treatment of any portion of the ITPH flow in the STP may require hazardous waste delisting activities. These activities would involve delisting the STP effluent from the lists of hazardous wastes identified in the hazardous waste regulations. These delisting activities may be both time intensive and costly, and will need to be addressed in any re-evaluation of treatment options for the ITPH water.

Other studies which are subordinate to the Zero-Offsite Water-Discharge Study will rely on the results presented in this report. Particular studies which will be influenced by this groundwater management report are: the Sanitary Treatment Plant Evaluation (Task 10); Process Water Reuse (Task 11); Reverse Osmosis Mechanical Evaporator (Task 12); Treated Wastewater Recycle (Task 13); Water Rights (Task 14); Groundwater Cutoff/Diversion (Task 26); Waste Generation/Treatment (Task 27); and Augmentation Plan (Task 28). Specific relationships and influences among these tasks will be addressed in the Consolidation Plan which will be written as a final step in preparing a Zero-Offsite Water-Discharge Plan for the RFP.

SOLAR POND INTERCEPTOR TRENCH SYSTEM
GROUNDWATER MANAGEMENT STUDY
Rocky Flats Plant Site

1.0 GENERAL

1.1 INTRODUCTION

The Solar Pond Interceptor Trench System Groundwater Management Study is a subordinate study to the Zero-Offsite Water-Discharge Study (ASI, 1990a) which is required by an Agreement in Principle signed by the Governor of the State of Colorado and by the Secretary of the Department of Energy on June 28, 1990. The Solar Pond Interceptor Trench System Groundwater Management Study provides an analysis of existing data regarding the quantity and quality of contaminated water that is transferred from the Solar Ponds Interceptor Trench system to the Rocky Flats Plant (RFP) Solar Evaporation Ponds (solar ponds). Contaminated groundwater and surface water have been collected near and transferred to the solar ponds since the early 1970s. Collection of the water was initiated and has continued due to the presence of elevated levels of nitrate and other contaminants in the water. In addition, this study provides an analysis of possible flow variations presented along with an analysis of the potential sensitivity of the system to certain modifications. Because the continued use of the solar ponds is being phased out, this information is needed to provide for the long-term management of the transferred water. Figures 1, 2a, and 2b are schematic representations of the current configuration of the solar pond area.

1.2 PURPOSE OF STUDY

The solar ponds at the RFP are undergoing Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response Compensation and Liability Act (CERCLA) investigation, characterization, and remediation activities as described in the draft Interagency

Agreement (IAG). This IAG process, along with the results of this study, will ultimately help determine the preferred remedial action at the solar ponds. The potential for Interim Remedial Actions and Final Actions related to the solar ponds will likely involve a water management program upgraded from the current water management program. The Interceptor Trench Pump House (ITPH) system is currently transferring contaminated water to Solar Pond 207B-North. Knowledge of the expected volume and chemical characteristics of this flow will allow the identification of an acceptable management program and the design of an appropriately sized treatment system for the water.

The conceptual design of a treatment system is currently anticipated to include the existing Interceptor Trench Pump House (ITPH) system to collect the leachate flows, a surge tank for containment of anticipated surge flows, and a treatment system sized to handle the existing average annual flows. The surge tank is a necessary unit due to the higher flows anticipated at certain times of the year. This report presents an analysis of the existing data regarding transferred groundwater flow quantity, quality, and appropriate treatment methods.

2.0 HISTORY

2.1 GENERAL SOLAR POND HISTORY

The RFP solar ponds have been used since 1953 to store and evaporate low-level process wastewater. The source of this wastewater has included various processing and waste-related operations at the RFP. The most notable characteristics of the wastewater stored in the solar ponds have been high nitrate concentrations and low levels of radioactivity. The presence of hazardous constituents in the stored wastewater is also expected due to the nature of the waste disposed in the solar ponds. Both the configuration and the uses of the solar ponds have changed a number of times over the years (Rockwell International, 1988a).

The original solar pond consisted of a clay lined impoundment. This impoundment was first used for waste management in December 1953. This original solar pond was operated with one and two cells until 1956, when its regular use was discontinued (Rockwell International, 1988a).

Solar Pond 207A (Figure 3) was placed in service in August 1956. The original lining consisted of asphalt planking, but the pond was relined with asphaltic concrete in 1963 (Rockwell International, 1988a). Solar Ponds 207B-North, Center, and South (Figure 3) were placed in service in June 1960. These ponds were also originally lined with asphalt planking but were relined in approximately 1961 with asphaltic concrete. The 207B ponds were relined in the late 1970s as a part of a water management plan being implemented at the RFP (Rockwell International, 1988a). Solar Pond 207C (Figure 3) was placed in service in December 1970 and was built with an asphaltic concrete liner. It is believed that solar pond 207C has not been relined since its construction (Rockwell International, 1988a). Table 1 summarizes approximate evaporative areas, maximum operating depth, and maximum waste volumes for each pond.

TABLE 1

SOLAR POND AREA AND WASTE INVENTORY*

SOLAR POND	APPROXIMATE EVAPORATIVE AREA (Square Feet)	APPROXIMATE MAXIMUM DEPTH (Feet)	APPROXIMATE MAXIMUM WASTE VOLUME (Gallons x 10^6)
207A	116,150	7.5	5.05
207B-NORTH	42,875	6.5	1.55
207B-CENTER	42,875	6.5	1.55
207B-SOUTH	42,875	5.5	1.40
207C	37,975	7.0	1.15

*SOURCE: Rockwell International, 1988a

2.2 TRENCHES AND SUMPS

Nitrate contamination of North Walnut Creek, located to the north of the solar ponds, was documented in the early 1970s. In response to this contamination, a series of trenches and sumps were installed north of the solar ponds during the period of 1971 to 1974. The trenches were French drains that flowed by gravity to a sump at the low end. The low point of most of the trenches was provided with a small pump and water level float system to activate the pump. The final configuration of the system consisted of two sumps and six trenches (Figure 4). Water collected in Sumps 1 and 2 was pumped to Solar Ponds 207B-North and 207A, respectively. Water collected in Trenches 1 and 2 was pumped uphill into Sumps 1 and 2. Water collected in Trench 3 was pumped directly to Solar Pond 207A, with water from Trench 4 pumped up to Trench 3. Trenches 5a and 5b, the only trench system not provided with a pump, drained by gravity to Trench 4. Water collected in Trench 6 was pumped to Solar Pond 207A (Rockwell International, 1988a). The locations of the sumps and trenches were established based upon evidence of nitrate-impacted vegetation. The water present in these areas was sampled, and if the presence of nitrate contamination was confirmed, a trench was typically installed. These trenches and sumps reduced natural seepage and pond leakage that might otherwise have entered North Walnut Creek, and were successful in reducing nitrate levels in North Walnut Creek (Maury Maas, Retired RFP Liquid Waste Personnel, pers. commun. September 9, 1990).

In addition to the trenches and sumps described above, an additional control structure was built to transfer water to Solar Pond 207A. This structure consisted of a wet-well with a submersible pump located in the area in which footing drain flows from Buildings 771 and 774 could be collected. The purpose of the system was to better manage contaminated water. The footing drain flows both daylight in the general location of the small pond due east of the currently unused condensate tanks that are north of Building 774. The pump would remove water from the area in which the footing drains daylighted and pump the water to Solar Pond 207C. It is believed that this system was constructed in approximately 1975. Rockwell International design drawing numbers 29147-1 and 29147-2 describe a system very similar to that which was built, but the actual system was observed to differ slightly from the one described in these drawings. Final as-built engineering drawings were not found for this control structure during the course of this study. This structure will be referred to as the West Collector throughout this report.

The trenches and sumps were in operation until the 1980s when they were replaced by a more extensive French drain system that was constructed as a part of the Perimeter Security Zone (PSZ) improvements. The trenches and sumps that were not destroyed in construction related to the PSZ were abandoned in-place by cutting their electrical power supply (Maury Maas, Retired RFP Liquid Waste Personnel, pers. commun. September 9, 1990).

2.3 PERIMETER SECURITY ZONE (PSZ) AND INTERCEPTOR TRENCH PUMP HOUSE (ITPH)

Construction of the PSZ in the early 1980s prompted major changes in the configuration of the contaminant control system near the solar ponds. These changes were needed due primarily to the destruction of Trenches 3 and 6. A much more extensive French drain system was designed and installed. The French drain system drains by gravity to a pump station located near North Walnut Creek. The pump station consists of a wet-well and a duplex installation of self-priming pumps. The wet-well of the pump station has two incoming flows, one from the west and one from the east. The pump station is identified by a number of names at the RFP, including: Main Sump, Main Nitrate Sump, Nitrate Sump, Solar Pond Sump, French Drain Sump, and others. In this report, the pump station will be referred to as the Interceptor Trench Pump House (ITPH) and the French drain system that drains to it will be referred to as the ITPH system. The original configuration of the system is given in Figure 5. Although the ITPH system was much more extensive than the trench and sump system that it replaced, the ITPH system was extended shortly after construction of the original parts of the ITPH system (Rockwell International, 1988a). It was this extension of the system that was referred to as the "Interceptor Trench."

2.5 HISTORY OF FLOW MEASUREMENT

No accurate long-term ITPH flow records have been developed. The original system was built without a flow meter. A paddle-wheel flow meter was installed on the force main leaving the ITPH in 1988, but its readings are considered inaccurate due to cavitation in the force main. Other projects which have not been completed will include the installation of a flow meter. Another method that could be used to estimate total return flows is based upon total pump operational time estimates made from electrical usage of the pump motors. However, there is no electric meter that is specific to the ITPH. Therefore, the best flow records available are the records of quantities of water pumped from Solar Pond 207B-North to the West Spray Field during 1982 through 1985, readings made of water depth in Solar Pond 207B-North for the last two years and two measurements of both inflows to the ITPH wet-well.

The ITPH system was extended due to concerns regarding the existence of groundwater seeps immediately north of the solar ponds. The extension of the ITPH system consisted of a new French drain that paralleled Patrol Road. This extension of the ITPH system was designed and built with a gravel backfill from the drain to the surface so that it would collect both groundwater and surface water flow. This extension also provided for the collection of footing drain flows from Buildings 771 and 774, described in Section 2.2 of this report, through a 4-inch diameter polyvinylchloride (PVC) pipe. This PVC pipe connected to the existing submersible pump assembly due east of the condensate tanks north of Building 774. This 4-inch diameter PVC pipe drains by gravity to a manhole that was installed where the extension of the ITPH system connects to the original ITPH system. Two drain pipes enter the manhole, one from the west (which includes the footing drain flows previously discussed), and one from the east. Both of these branches flow by gravity to the ITPH extension manhole. This manhole drains by gravity to the west incoming pipe of the ITPH wet-well. As previously discussed, the ITPH transfers incoming water to Solar Pond 207B-North. The final configuration of the ITPH system is shown in Figure 6.

2.4 CURRENT SYSTEM CONFIGURATION/DESIGN

In general, the ITPH system was designed to collect contaminated groundwater; however, the West Collector collects a surface water flow, as do the east and west extensions to the ITPH system. The ITPH system and its east and west extensions have been in operation since they were installed. Old Sumps 1 and 2 and old Trenches 1, 2, and 4 still exist, but their pumps are not provided with power. Trench 2 and Sump 2 are currently sources of surface water flow, or seepage (Figure 2a). This surface water flow, at least in part, bypasses the ITPH system. These partial bypasses occur because certain areas of the gravel surface of the ITPH extension have been covered with soil or have been eroded by runoff.

3.0 WATER QUANTITY

An estimate of the total quantity of water transferred to the solar ponds by the ITPH system has been developed through three separate, independent analyses. After review and evaluation of all available data and estimation methods, it is believed that the best estimate of the transferred groundwater flow is an annual average of approximately 5.9 gpm (3,100,000 gallons per year). The three methods used to arrive at this estimate of transferred flow are described below.

1) An approximate water balance around Solar Pond 207B-North, based upon West Spray Field pumping records from 1982 through 1985, indicates a total annual transfer flow of approximately 3,043,000 gallons.

2) An approximate water balance around Solar Ponds 207B North, Center, and South based upon depth readings and transfer records from the ponds from 1988 through 1990 indicates a total annual transfer flow of approximately 3,149,000 gallons.

3) Two discrete measurements of inflows to the ITPH wet-well indicated total flow into the ITPH wet-well was 4.45 gpm (approximately 2,338,900 gallons per year), and 4.90 gpm (approximately 2,575,400 gallons per year). These measurements were made on July 11 and 12, 1988 and September 11, 1990.

Additionally, changes in water volume at the solar ponds in 1986 - 1987 also provide information that supports the numbers developed by the three other estimation methods.

METHOD 1: FLOW ESTIMATION

Operation of the West Spray Field began in 1982. This spray field was built and operated to provide additional evaporation of RFP waters. In particular, the spray field was built to manage water transferred to Solar Pond 207B-North from the ITPH system. It was operated from the

TABLE 2

APPLICATION OF LIQUID FROM SOLAR POND 207B-CENTER TO THE WEST SPRAY FIELD*

DATE	VOLUME APPLIED (gallons)
4/82	2,971,000
5/82	4,869,000
6/82	3,307,000
7/82	3,179,000
8/82	2,130,000
9/82	2,334,000
10/82	3,371,000
11/82	3,018,000
12/82	434,000
Yearly Subtotal	25,613,000
1/83	556,000
2/83	1,193,000
3/83	760,000
5/83	820,000
6/83	1,135,000
7/83	2,140,000
8/83	1,426,000
9/83	1,277,000
10/83	1,859,000
11/83	1,691,000
12/83	2,493,000
Yearly Subtotal	15,350,000

* Source: Rockwell International, 1988a.

TABLE 2
(continued)

APPLICATION OF LIQUID FROM POND 207B-CENTER TO THE WEST SPRAY FIELD

DATE	VOLUME APPLIED (gallons)
2/84	2,209,000
3/84	710,000
4/84	597,000
5/84	2,315,000
6/84	1,901,000
7/84	1,488,000
10/84	660,000
12/84	1,825,000
Yearly Subtotal	11,705,000
1/85	2,087,000
2/85	250,000
3/85	455,000
4/85	1,265,000
5/85	110,000
6/85	528,000
Yearly Subtotal	4,695,000
TOTAL 1982 through 1985	57,363,000

TABLE 3

APPLICATION OF LIQUID FROM POND 207B-NORTH TO THE WEST SPRAY FIELD*

DATE	VOLUME APPLIED (gallons)
4/82	522,000
6/82	760,000
10/82	244,000
Yearly Subtotal	1,526,000
1/83	555,000
6/83	865,000
7/83	1,112,000
11/83	367,000
Yearly Subtotal	2,899,000
3/84	231,000
4/84	864,000
5/84	216,000
7/84	169,000
10/84	929,000
Yearly Subtotal	2,409,000
3/85	132,000
7/85	1,266,000
10/85	781,000
Yearly Subtotal	2,179,000
TOTAL 1982 through 1985	9,013,000

* Source: Rockwell International, 1988a.

METHOD 2: WATER BALANCE

An estimate of the quantity of water transferred by the ITPH system to Solar Pond 207B-North can be made by reducing the daily water level measurements in Solar Pond 207B-North to daily water volume changes for the period from March 1989 through March 1990. Transfers of water from Solar Pond 207B-North to other solar ponds or to the Building 374 Evaporator must be accounted for as well. Such transfers were routinely made to Solar Ponds 207B North, Center, and South and to the 374 Evaporator; however, some transfers of water to Solar Pond 207A were also made after March 1990. Monthly volumetric changes in Solar Ponds 207B-North, Center, and South can be combined with monthly net evaporation. The total volume can then be combined with monthly transfers to result in the total monthly ITPH pump output. This amount is the quantity of water the ITPH pumps must add to Solar Ponds 207B-North, Center, and South per month.

The records of the water levels in Solar Ponds 207B-North, Center, and South for March 1989 to March 1990 were analyzed. Monthly changes in water volume were calculated for each pond and these results combined. The total change in volume for the 12-month period, from March 1989 to March 1990, was calculated to be an increase of 776,000 gallons. The volume of evaporation from this period was 1,121,500 gallons (NOAA, 1990). The volumetric increase due to precipitation into each pond for this period was calculated to be 366,200 gallons (RFP Meteorological Station Data). The net evaporation from the three ponds for this period was 2,266,000 gallons. The gross transfer from Solar Ponds 207B-North and Center was 107,200 gallons. Consequently, the estimated annual output of the ITPH pumps based on data from March 1989 to March 1990 is 3,149,200 gallons (Figure 8). Summary calculations for this water balance estimate are presented in Appendix B.

METHOD 3: FLOW MEASUREMENTS

In addition to the information provided above, limited flow measurements have been made at the ITPH wet-well. These discrete flow measurements have been taken as a part of the surface water sampling activities. Typically, only the flow entering the wet-well from the east has been measured, however on July 11 and 12, 1988, and September 11, 1990, both the east and west incoming flows were measured. The total inflow to the ITPH system on July 11 and 12, 1988 averaged 4.45 gallons per minute (gpm) (this is equivalent to 2,338,900 gallons per year). The total inflow to the ITPH system on September 11, 1990 averaged 4.90 gpm (equivalent to 2,575,400 gallons per year). These estimates of total flows into the ITPH system correspond well with the estimated total annual flows developed previously for this study. These flows were measured during relatively dry periods of the year, possibly accounting for the somewhat smaller total transferred flow estimate compared with earlier estimates (Figure 9).

In addition to the foregoing, changes in water levels of the solar ponds in 1986 and 1987 also provide information that gives an indication of possible annual maximum flows. In September 1986, Solar Pond 207B-North was approximately half full and Solar Ponds 207B-Center and South were approximately empty. By September 1987, Solar Ponds 207B-Center and South were approximately full and Solar Pond 207B-North was still approximately half full. Most ITPH water was transferred strictly to Solar Pond 207B-North, Center, and South; however, it is possible that some ITPH water was transferred to Solar Pond 207A.

Accounting for the volume changes in Solar Pond 207B-North, Center, and South as well as evaporative losses, the transferred ITPH flow in this one-year period accounted for approximately 4,535,000 gallons (Figure 10). The twelve-month period in which this flow was transferred to the solar ponds was a relatively wet period. This quantity may therefore indicate, to some extent, the change in transferred water volumes in response to wet years. The transferred flow estimate developed for 1986 - 1987 is of a lesser accuracy than the previously developed estimates due to the lack of detailed records regarding the change in water volumes contained in the solar ponds during this period. This value was not combined with the estimates developed from the previous three methods in evaluating average annual quantities of ITPH water transferred to the solar ponds.

3.1 DISCRETE PORTIONS

3.1.1 West Collector

Flow records from the Building 774/771 footing drain area are not available because no flow measurement device has been installed. As previously described, the system flows by gravity into the extended ITPH system and is thereby transferred to Solar Pond 207B-North. Occasional observations since 1988 indicate there are no large fluctuations in flow from the footing drain area. Given the assumption of fairly stable flow rates, the total flow from the system can be estimated based upon a limited number of measurements. Flow at the West Collector was estimated on September 7 and 17, 1990, based on the recovery of the water level in the well after displacement of a volume of water. These measurements indicate the flow into the ITPH system from this area is on the order of 1.2 - 1.3 gpm (actual discrete measurements were 1.3 gpm on September 7th, and 1.2 gpm on September 17th). Given these data, it is estimated that 1.3 gpm represents an average flow at the West Collector. This portion of the ITPH system therefore accounts for about 683,000 gallons per year, or approximately 22% of the total annual flow pumped back to the solar ponds.

3.1.2 East Extension to ITPH

Continuous flow records from the manhole on the extended ITPH system are not available because no flow measurement device has been installed. Measurement of the flow entering the ITPH extension manhole from the eastern branch of the extension has been made at the same time water samples have been collected from the ITPH system (Table 4). At times, accurate flow

TABLE 4

FLOWS MEASURED AT ITPH EXTENSION MANHOLE

Eastern Inflow to ITPH Extension Manhole (Site SW087)

Date	Flow (gpm)
07/11/88	0.9
04/13/89	4.5
05/10/89	0.0
06/05/89	4.5
04/16/90	1.8
05/07/90	1.3
06/27/90	NM
07/17/90	NM
08/15/90	NM
09/10/90	NM
09/11/90	0.8

Western Inflow to ITPH Extension Manhole (Site SW088)

Date	Flow (gpm)
07/11/88	0.9
06/05/89	9.0
04/17/90	NM
05/07/90	NM
06/27/90	NM
07/17/90	NM
08/15/90	NM
09/10/90	NM
09/11/90	NM

NM = Flow Not Measured calculations indicate that the additional flow collected by the eastern portion of the extended ITPH system during storm events may be as high as 725,700 gallons per year.

measurement at this location is impossible because the flow runs down the wall of the manhole rather than cascading into the manhole.

As previously discussed, the ITPH extension was designed to collect both groundwater and surface water flows. Large fluctuations in flow are therefore expected due to collection of stormwater runoff. Weather conditions were dry during the flow measurement of September 11, 1990, with no stormwater runoff being collected by the extended ITPH system. Therefore the average (arithmetic) measured flow, 2.0 gpm (or 34% of the total ITPH flow), can be considered a baseline flow to which stormwater flows would be added during precipitation events.

Groundwater seeps have been observed just east and uphill of the manhole on the extended ITPH system. On September 11, 1990, only a part of this seepage flow was collected by the ITPH system extension. Uncollected seepage flowed over the eastern extension of the ITPH system because soil has covered portions of the gravel intended to allow collection of seepage. Seepage not intercepted by the ITPH system is directed by topography into North Walnut Creek. Soil partially covers the gravel because of vehicular traffic on the hillside and normal soil transport caused by stormwater runoff. The system is scheduled to be repaired in the near future so that all of the seepage flow will be collected (Pete Folger, EG&G-ER/EMAD, Pers. commun., September 27, 1990). These repairs will consist of removal of the soils covering the gravel of the ITPH system extension. The increased flow in the system due to collection of additional seepage flows should be measured following these repairs. It is currently estimated that the increase in flows will be small and may not be measurable.

The total additional flow due to stormwater runoff in the eastern portion of the ITPH extension can be estimated based upon the area from which the system would collect stormwater runoff and typical runoff coefficients (DRCOG, 1969). On the basis of these data, calculations indicate the flow collected by the eastern portion of the extended ITPH system during storm events may be as high as 725,740 gallons per year. Calculations for estimating the collected runoff from this part of the ITPH extension are provided in Appendix C.

3.1.3 West Extension to ITPH System

Limited flow data exist from water sampling activities at the western inflow to the manhole on the extended ITPH system (Table 4). As previously described, the two branches of the extended system flow by gravity into the manhole which drains to the ITPH wet-well through the west branch of the ITPH system. The water from the ITPH wet-well is transferred to Solar Pond 207B-North. The pipe connecting the manhole to the west extension is flush with the wall of the manhole. Incoming water often runs down the manhole wall rather than cascading into the manhole. When water is flowing down the side of the manhole, a visual estimate of flow is not possible. Flow measurements at this station were made on July 11, 1988 (0.9 gpm) and June 5, 1989 (9.0 gpm). At other times, inflow from the western extension has been observed by surface water-sampling personnel but not measured.

It is believed that of the two measured flows, the flow of 0.9 gpm best represents minimum flow conditions. This is based upon the observation of flows of 1.2 - 1.3 gpm at the west collector of the ITPH extension (Section 3.2.1) and the fact that the flow at this point should consist of flow from the west collector and any flow collected by the ITPH extension. Flows were measured at most points of the ITPH system on July 11 and 12, 1988, allowing comparison of flows at various points of the system. The measured flow from the western ITPH extension equalled approximately 20% of the total flow to the ITPH system for that period. Based on the results of the calculations given above, an average annual flow of 1.3 gpm (683,000 gallons per year), has been assumed at this point of the ITPH system. This accounts for approximately 22% of total annual flow from the ITPH system.

The ITPH extension was designed to collect both groundwater and surface water flows and consequently large fluctuations in flow can be expected. The total flow due to stormwater runoff can be estimated from the area from which stormwater runoff would be collected and from typical runoff coefficients. Based on these data, calculations indicate that the stormwater runoff flow collected by the western portion of the extended ITPH system during storm events may be as high as 1,156,648 gallons per year. Calculations of the collected runoff from this portion of the ITPH extension are provided in Appendix C.

It is expected that at times the flow into the manhole will be great enough to allow flow measurement as the incoming water cascades into the manhole. Flow into the manhole should be measured if sampling occurs at these times.

3.1.4 East Inflow to ITPH

The flow coming into the ITPH wet-well from the east portion of the ITPH system has been measured a number of times due to its accessibility (Table 5). Inflow values from the east ITPH system have varied from 1.0 to 2.7 gpm. Based on these data, the average (arithmetic) inflow from the east ITPH system is approximately 1.6 gpm (841,000 gallons per year) or 27% of the total ITPH system flow.

3.1.5 West Inflow to ITPH

The ITPH wet-well incoming flow from the western portion of the ITPH system, which includes all flow from the ITPH extension, has been measured twice (Table 5). The measured flows were 3.5 gpm on July 12, 1988 and 3.6 gpm on September 11, 1990. These flows accounted for 78% and 73%, respectively, of the total ITPH system flow on the day of measurement. It is expected that the average flow from this portion of the ITPH system accounts for 3.6 gpm (1,892,000 gallons per year) or 61% of the total ITPH system flow.

3.1.6 Summary of Discrete Flows

Table 6 summarizes flow in discrete portions of the ITPH system. Total ITPH system flow is estimated at 5.9 gpm, which is the flow value to which other flows are compared.

TABLE 5

FLOWS MEASURED AT ITPH

Eastern Inflow to ITPH (Site SW094)

Date	Flow (gpm)
07/12/88	1.0
04/30/90	2.7
05/24/90	1.8
06/26/90	1.3
07/24/90	1.3
08/29/90	NM
09/11/90	1.3

Western Inflow to ITPH (Site SW095)

Date	Flow (gpm)
07/12/88	3.5
04/30/90	NM
05/30/90	NM
06/26/90	NM
07/24/90	NM
08/29/90	NM
09/11/90	3.6

NM = Flow Not Measured

TABLE 6

SUMMARY OF ITPH SYSTEM FLOW ESTIMATES

Portion of System	Estimated Flow (gpm)	Percentage of Total ITPH Flow
All	5.9	100
West Collector	1.3	22
E. Extension Inflow	2.0	34
W. Extension Inflow	1.3*	22
E. ITPH Inflow	1.6	27
W. ITPH Inflow	3.6	61

NOTE: The east and west inflows to the ITPH only account for 88% of the total flow. One of the reasons for the slight discrepancy between the total annual flow and the summation of the portions of the flow is the total flow is based on a number of data sources accounting for a number of years of data. The flow measurements on portions of the system are based on a limited data record with several measurements being made during dry periods. It is judged that the slight discrepancy is due to the different basis of the data.

* This is an assumed flow. Although flows have been measured at this location, only two measurements have been made. These measurements were an order of magnitude different, and therefore, the flow reported for this location is simply the flow recorded at the West Collector. This number should represent a minimum flow at the point of measurement.

3.2 PUMP HOUSE/FORCE MAIN DESIGN CAPACITIES AND MAXIMUM FLOWS

The ITPH is a duplex pump station. The pumps are Gorman-Rupp Model 82H2C-B self-priming pumps running at 2900 revolutions per minute (RPM), driven by 10 horsepower (HP) motors. The force main through which this water is pumped is a 3-inch inside diameter polyvinylchloride (PVC) pipe. Appendix D is an evaluation of the quantities of water the pump station and force main can handle. The approximate pumping capacities are 80 gpm with a single pump operating, and 100 gpm with both pumps operating. Any incoming flows that significantly exceed 100 gpm would fill the wet-well increasing the potential for the wet-well to overflow. Overflow of the wet-well has occasionally occurred during wet weather conditions. This indicates that the total capacity of the system is not adequate and additional capacity should be provided. This additional capacity could be provided by pump replacement with pumps of greater capacity or by the installation of an additional force main parallel to the existing force main.

3.3 MAXIMUM FLOWS AND RELATIONSHIP TO PRECIPITATION

Following major storm events on June 27 (2.80-inches) and June 30 (2.20-inches), 1987, it is believed that both ITPH pumps ran continuously for approximately two days. The return period of individual storms of this magnitude is approximately seven and three years, respectively, with the return period of such back-to-back storms approximately 20 years. The total flow that was pumped back in the June 27 and 30 period was approximately 290,000 gallons. This value represents the maximum quantity of water the ITPH system is currently capable of returning to the solar ponds in any two day period. It is probable actual incoming flow to the ITPH wet-well during that period exceeded 290,000 gallons, because it is possible that the wet-well overflowed during that period.

3.4 RECOMMENDATIONS

The following recommendations are made with respect to quantification of the various flows transferred to the Solar Evaporation Ponds:

1. An accurate flow meter and flow totalizer should be installed on the force main of the ITPH system. Flow records should be maintained on a daily basis.

2. Flow data should continue to be generated for each incoming branch of flow (both east and west) at the ITPH extension manhole. However, measurement of the incoming flow from the west branch of the ITPH extension may not always be possible. At a minimum these flow readings should be taken when water samples are collected. Modification of the existing system should be considered to allow routine measurement of the incoming flow from the west branch of the ITPH extension.

3. Flow data should continue to be generated for each incoming branch of flow (both east and west) at the ITPH wet-well. At a minimum these flow readings should be taken when samples are collected for water-quality analyses.

4. Additional flow data should be generated for the Building 774/771 footing drain flow. These data can be obtained when water samples are collected.

4.0 WATER QUALITY

Water quality has been analyzed from surface water monitoring stations and groundwater monitoring wells in the vicinity of the solar ponds. A review was made of water quality analyses from recent hydrologic studies performed at the RFP (EG&G, 1990a; EG&G, 1990b). As stated, the ponds were historically used to store and evaporate process wastes including those with low-level radioactivity, high nitrates, acids, and other chemical constituents. Evidence indicates the groundwater in the area of the solar ponds has been impacted by leakage from the ponds (EG&G, 1990b). To characterize the quality of the water in the ITPH system, surface water and groundwater samples have been taken from the discrete portions of the ITPH drain system and analyzed. These samples have been found to have different chemical compositions. It should be noted that available data were used in this evaluation. EG&G Rocky Flats has an on-going extensive QA/QC program to determine the quality of the data and the suitable uses of data based upon the objective of that use. Therefore, this evaluation and discussion may be revised in the future depending upon both the results of new analyses and the results of the QA/QC program.

4.1 OVERALL WATER QUALITY

Available water quality sampling data from 1988 to 1990 indicate the presence of elevated concentrations of inorganic constituents, radionuclides, and volatile organic compounds (VOCs) in the solar pond area. Several specific compounds were evaluated in this study as representatives of these groups of contaminants. This discussion of water quality is cursory and intended as an overview. More detailed water-quality studies of the solar pond area have been performed in recent years (EG&G, 1990b). A review of these data indicate the greatest concentrations of VOCs to be in the surface water in the area of the West Collector. Elevated concentrations of inorganic constituents are indicated in the area to the north of Solar Pond 207-B North. Radionuclides appear to be present throughout the ITPH system and solar pond area. Figures 11 and 12 indicate the locations of the surface water monitoring sites and groundwater monitoring wells used in this study. Tables 7 and 8 present the concentrations of selected

TABLE 7
CONCENTRATIONS OF SELECTED PARAMETERS IN SURFACE WATER
SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

STATION NUMBER	TEST DATE	AMERICIUM 241 (PCI/L)	GROSS ALPHA (PCI/L)	GROSS BETA (PCI/L)	PLUTONIUM 239 (PCI/L)	RADIUM-226 (PCI/L)	RADIUM-228 (PCI/L)	NITRATE (MG/L)	NITRATE/ NITRITE (MG/L)	DISSOLVED SOLIDS (MG/L)	pH (pH-UNITS
SW084	Jun-88		2.87	6.5	0.162			105.3626	23.8	524	8.4
	Jun-88				0.263						
	Jun-89	0.04	17	11	0.03	0.03					
	Jul-89	0.23	83	46	0.32	1.1					
	Aug-89	0.08	45	35	0.02	1.6					
	Sep-89	0.03	4	19	0.009	NR	NR				
	Oct-89								5.7	220	7.
	Jan-90								5.3	200	7.
	Feb-90								6.4	560	7.
	Mar-90								13	340	7.
SW085	Jul-88				0.215			123.956	28	1080	7.9
	Jul-88		13.1	43.3	0.146						
	May-89	0.52	120	120	1.0	3.7					
	Jun-89	0.56	240	170	1.3	2.5					
	Jul-89	0.32	47	44	0.70	0.9					
	Aug-89	0.21		560	0.32	20	52				
	Aug-89		1000								
	Sep-89	0.07	13	56	0.33	0.6	NR				
	Oct-89								15	440	7.
	Feb-90								20		
	Mar-90								31	630	7.

NOTES:
1) SEE FIGURE 10 FOR MONITORING SITE LOCATIONS.
2) THESE DATA WERE OBTAINED FROM THE RFP RFEDS DATABASE. VALUES PRESENTED ON THESE TABLES ARE IDENTICAL TO THOSE PROVIDED BY RFP.
3) NR = NOT REPORTED.
4) SHADED PARAMETERS ARE INCLUDED ON FIGURE 12.

SHEET 1

TABLE 7 (con't)

CONCENTRATIONS OF SELECTED PARAMETERS IN SURFACE WATER

SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

STATION NUMBER	TEST DATE	AMERICIUM 241 (PCI/L)	GROSS ALPHA (PCI/L)	GROSS BETA (PCI/L)	PLUTONIUM 239 (PCI/L)	RADIUM-226 (PCI/L)	RADIUM-228 (PCI/L)	NITRATE (MG/L)	NITRATE/ NITRITE (MG/L)	DISSOLVED SOLIDS (MG/L)	pH (pH-UNITS)
SW086	Jul-88				0.242			76.686	18	526	7.6
	Jul-88		0	7.01	0.0476						
	May-89	0.12	10	9	0.08	0.1					
	Jun-89	0	4	7	0.02						
	Jul-89	0.02	6	11	0.03	0.3					
	Aug-89	1.8	44	33	0.2	0.4					
	Sep-89	0.08	6	19	0.028	NR	NR				
	Oct-89								9.7	310	7
	Jan-90								8.7	260	7
	Feb-90								14	310	7
	Mar-90								12	330	7
SW087	Jul-88				0.0808			6671.489	1507	9106	7.[illegible]
	Jul-88		74.8	384	0.356						
	May-89	0.01	710	750	0.34	1.7					
	Jun-89	<0.01	330	370	0.03	1.4		4427	1000	7900	7
	Jun-89	0	370	430	0.02	0.9					
	Aug-89										
	Sep-89	0.02	89	186	0.04	1.4	NR				
	Oct-89								490	4400	7
	Jan-90								270	2400	7
	Feb-90								430	3200	7
	Mar-90								290	2600	7
SW088	Jul-88				0.887			314.317	71	914	7.[illegible]
	Jul-88		3.37	19.2	0.264						
	May-89	0.17	220	230	0.13	0.5					
	Jun-89	0	18	11	0.02	0.3					
	Aug-89										
	Sep-89	0.03	64	150	0.04	0.2	NR				
	Oct-89								520	4100	7
	Jan-90								290	2300	7
	Feb-90								440	3200	7
	Mar-90								300	2600	7

SHEET 2

TABLE 7 (con't)

CONCENTRATIONS OF SELECTED PARAMETERS IN SURFACE WATER

SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

STATION NUMBER	TEST DATE	AMERICIUM 241 (PCI/L)	GROSS ALPHA (PCI/L)	GROSS BETA (PCI/L)	PLUTONIUM 239 (PCI/L)	RADIUM-226 (PCI/L)	RADIUM-228 (PCI/L)	NITRATE (MG/L)	NITRATE/ NITRITE (MG/L)	DISSOLVED SOLIDS (MG/L)	pH (pH-UNITS
SW089	Jul-88		438								
	Jul-88		156	438	3.43						
	Apr-89	0.02	440	380	31	0.4					
	Apr-89	16	470	340	0.15						
	May-89	0.64	280	280	2.4	0.4					
	Jun-89	90	780	450	120	5	18				
	Jun-89		720								
	Jul-89	0.45	700	570	5.4	1.9					
	Aug-89	5.5	670	530	1.2	3.1	10				
	Aug-89	5.5	670	530	1.2	3.1	10				
	Oct-89								700	5600	7.
	Feb-90	5.166							510	4700	7.
	Mar-90								320	2700	7.
SW090	Jul-88				0			5578.02	1260	11622	6.8
	Jul-88		274	1330	0.00244						
	Jun-89	0.06	130	320	0.08	0.1					
	Jul-89	0	1400	2500	0.22	3.1	17				
	Aug-89	0	440	950	0	0.7					
	Sep-89				0.015						
	Oct-89								3400	25000	7.
	Oct-89								3100	24000	7.
	Jan-90								3200	4400	7.
	Feb-90								5900	47000	4.
	Feb-90								7800	46000	4.
	Mar-90								680	5100	7.
SW091	Mar-90								2.2	290	

TABLE 7 (con't)
CONCENTRATIONS OF SELECTED PARAMETERS IN SURFACE WATER
SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

STATION NUMBER	TEST DATE	AMERICIUM 241 (PCI/L)	GROSS ALPHA (PCI/L)	GROSS BETA (PCI/L)	PLUTONIUM 239 (PCI/L)	RADIUM-226 (PCI/L)	RADIUM-228 (PCI/L)	NITRATE (MG/L)	NITRATE/ NITRITE (MG/L)	DISSOLVED SOLIDS (MG/L)	pH (pH-UNIT
SW094	Jul-88				0.535			1509.607	341	2350	7.
	Jul-88			47.4	0			1518.461	343	2360	7.
	Jul-88		4.1	40.4	0.153						
	Jul-88		10.8		0						
	May-89	0.05	120	110	0.02	0.9					
	May-89	0.01	150	130	0.01	0.7					
	Jul-89	0.01	95	130	0.01	0.4					
	Jul-89	0.02	64	140	0.02	0.3					
	Sep-89	0.009	50	140	0.015	0.6	NR				
	Sep-89	0.009	9	140	0.02	0.3	NR				
	Oct-89	0.02	99.4	138	0.017						
	Feb-90								610	4600	
	Mar-90								280	2500	
SW095	Jul-88				0.838			3205.148	724	4555	6.
	Jul-88		50.1	135	0.09						
	May-89	0	140	160	0.01	0.6					
	Jul-89	0.02	62	160	0.04	0.5					
	Sep-89	0.02	48	130	0.009	1		1859.34	420	3400	
	Oct-89		81.9	145	0.01						
	Feb-90								690	4400	
	Mar-90								330	2700	
SW102	Jul-88			23.9	0			68.6185	15.5	619	
	Jul-88		3.39		0.0792						
	Sep-89				0.03			40.7284	9.2	290	
	Mar-90								15	450	

TABLE 7 (con't)
CONCENTRATIONS OF SELECTED PARAMETERS IN SURFACE WATER
SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

STATION NUMBER	TEST DATE	AMERICIUM 241 (PCI/L)	GROSS ALPHA (PCI/L)	GROSS BETA (PCI/L)	PLUTONIUM 239 (PCI/L)	RADIUM-226 (PCI/L)	RADIUM-228 (PCI/L)	NITRATE (MG/L)	NITRATE/ NITRITE (MG/L)	DISSOLVED SOLIDS (MG/L)	pH (pH-UNIT
SW105	Jul-88				0			7255.853	1639	12900	7.
	Jul-88		116	490	0						
	Jul-88				0						
	Jul-88		151	417	0						
	May-89	0.02	160	300	0.07	0.2					
	Jun-89	0.06	21	46	0.12	0.5					
	Aug-89										
	Sep-89	0.015	260	1040	0.043	1	NR				
	Oct-89								1500	12000	
	Jan-90								510	6500	7
	Jan-90								870	6400	7
	Feb-90								1900	12000	7
	Mar-90								770	6200	7.
SW106	Jun-89	0.01	26	42	0.00	0.1					
	Mar-90								67	780	7.

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TABLE 8
CONCENTRATIONS OF SELECTED PARAMETERS IN GROUNDWATER
SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

STATION NUMBER	TEST DATE	AMERICIUM 241 (PCI/L)	GROSS ALPHA (PCI/L)	PLUTONIUM 239 (PCI/L)	RADIUM-226 (PCI/L)	NITRATE/ NITRITE (MG/L)	DISSOLVED SOLIDS (MG/L)	pH (pH-UNITS)
0260	Jan-88	NR	22 +/- 16	..	NR	1279	971	NR
	Mar-88	..	16 +/- 50	..	NR	15.1	2453	NR
	May-88	..	63 +/- 21	..	NR	2050	17400	NR
	Sep-88	0.01 +/- 0.01	..	..	NR	1696	14400	NR
	Dec-88	0.03 +/- 0.02	..	..	NR	185	12580	NR
	Feb-89	NR	NR	NR	NR	1750	12070	NR
	May-89	NR	53.8 +/- 19.4	NR	NR	1830	15490	NR
	Nov-89	NR	NR	NR	NR	2100	..	..
1786	Mar-88	..	28 +/- 12	..		540	4392	NR
	May-88	..	34 +/- 12	..		577	5214	NR
	Aug-88	..	26 +/- 58	0.05 +/- 0.02		635	4658	NR
	Nov-88	..	110 +/- 70	..		763	4204	NR
	Feb-89	NR	NR	NR		598	4283	NR
	May-89	NR	15.4 +/- 8.6	NR		534	4469	NR
1886	Mar-88	DRY	DRY	DRY	DRY	DRY	DRY	DRY
	May-88	DRY	DRY	DRY	DRY	DRY	DRY	DRY
	Aug-88	DRY	DRY	DRY	DRY	DRY	DRY	DRY
	Nov-88	DRY	DRY	DRY	DRY	DRY	DRY	DRY
	Feb-89	DRY	DRY	DRY	DRY	DRY	DRY	DRY
	May-89	DRY	DRY	DRY	DRY	DRY	DRY	DRY
	Dec-89	DRY	DRY	DRY	DRY	DRY	DRY	DRY
2086	Mar-88	DRY	DRY	DRY	DRY	DRY	DRY	DRY
	May-88	DRY	DRY	DRY	DRY	DRY	DRY	DRY
	Sep-88	DRY	DRY	DRY	DRY	DRY	DRY	DRY
	Nov-88	DRY	DRY	DRY	DRY	DRY	DRY	DRY
	Feb-89	DRY	DRY	DRY	DRY	DRY	DRY	DRY
	May-89	DRY	DRY	DRY	DRY	DRY	DRY	DRY
B208489	Aug-89	DRY	DRY	DRY	DRY	DRY	DRY	DRY
P208889	Sep-89					..	..	..
P208989	Sep-89					1400	13000	..
P209589	Sep-89					4800	31000	..
P210089	Sep-89	NR	NR	NR	NR	150	NR	NR
P209489	Sep-89	0.570 +/- 0.095	41.2 +/- 8.9	..	NR	400	3400	..

NOTES:
1) SEE FIGURE 11 FOR WELL LOCATIONS
2) NR = NOT REPORTED.
3) .. = NOT DETECTED OR BELOW TOLERANCE LEVEL.
4) THESE DATA WERE OBTAINED FROM THE RFP RFEDS DATABASE. VALUES PRESENTED IN THESE TABLES ARE IDENTICAL TO THOSE PROVIDED BY RFP.
5) SHADED PARAMETERS ARE INCLUDED ON FIGURE 15.

TABLE 8 (con't)
CONCENTRATIONS OF SELECTED PARAMETERS IN GROUNDWATER
SOLAR POND INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

STATION NUMBER	TEST DATE	AMERICIUM 241 (PCI/L)	GROSS ALPHA (PCI/L)	PLUTONIUM 239 (PCI/L)	RADIUM-226 (PCI/L)	NITRATE/ NITRITE (MG/L)	DISSOLVED SOLIDS (MG/L)	pH (pH-UNITS)
3086	Jan-88	NR	304 +/- 69	..	NR	1457	13682	NR
	Jan-88							
	Mar-88	NR	320 +/- 60	..	NR	1410	10571	NR
	May-88	0.02 +/- 0.07	390 +/- 60	..	NR	12100	1600	NR
	Sep-88	0.03 +/- 0.01	220 +/- 170	0.58 +/- 0.29	NR	1611	12125	NR
	Dec-88	0.02 +/- 0.02	120 +/- 110	..	NR	1431	9750	NR
	Mar-89	NR	NR	NR	NR	1030	7290	NR
	May-89	NR	150 +/- 11	NR	NR	7697	874	NR
	Sep-89	NR	113 +/- 17	NR	NR			
	Nov-89					1400	8800	..
	Nov-89					2100	8700	..
3286	Mar-88	.1 +/- .1	..	..		..	..	NR
	May-88	..	..	..		..	..	NR
	Sep-88	02 +/- .01	..	0.01+/-0.01		..	..	NR
	Dec-88	..	..	..		1.4	..	NR
	Mar-89	NR	..	NR		..	..	NR
	May-89	NR	..	NR		..	..	NR
3987BR	Mar-88	..	..	0.01 +/- 0.10		..	..	..
	May-88	..	..	..		..	..	..
	Sep-88		..					

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inorganic constituents and radionuclides in both surface water and groundwater. Tables 9 and 10 present the concentrations of selected VOCs in surface water and groundwater. Figures 13, 14, 15, and 16 indicate concentrations of selected VOCs, inorganic constituents, and radionuclides for the monitoring locations presented on Figures 11 and 12.

4.1.1 Geology

Groundwater quality is influenced by the material through which it travels. Water-quality analyses from the Solar Pond area indicate significant spatial variations reflecting in part the different characteristics of the geologic units. The general geology of the solar pond area is represented by bedrock covered with a thin veneer of unconsolidated materials (EG&G, 1990a). Bedrock consists of a silty claystone of the Arapahoe Formation with distinct sandstone channels. Both units are weathered to varying degrees near the surface and at contacts with overburden. The Rocky Flats Alluvium (Qrf) and Valley Fill Colluvium (Qvf) are the unconsolidated surficial materials in the area and are typically less than 10 feet thick.

Data from borehole logs in the solar pond area indicate a meander segment of the Arapahoe Sandstone Number 1 channel subcrops below the Rocky Flats Alluvium in the area of Solar Pond 207C. The surface of the sandstone is at an approximate elevation of 5969 feet above mean sea level (MSL). The channel is approximately 400 feet wide in the solar pond area and may be as thick as 20 feet. The overbank material surrounding the sandstone is predominantly silty claystone. Based on hydraulic conductivity values for other subcropping Arapahoe sandstones on the plant site, the hydraulic conductivity of Sandstone Number 1 in the solar pond area is expected to be 10^{-5} centimeters per second (cm/sec). The hydraulic conductivity of the surrounding claystone is expected to be on the order of 10^{-7} cm/sec. Figure 17 is a schematic isopach map of Sandstone Number 1 in the solar pond area.

TABLE 9
CONCENTRATIONS OF SELECTED VOCs IN SURFACE WATER
SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

Station Number	Sample Date	Methylene Chloride (ug/l) CH2CL2	Acetone (ug/l) (CH3)2CO	Total-1,2-Dichloro ethene (ug/l)	Tri-Chloro-methane (ug/l)	1,2-Di-chloro-ethane (ug/l)	1,1,1-Tri Chloro-ethane (ug/l) TCA	Carbon Tetra-chloride (ug/l) CCl4	Trichloro ethene (ug/l) TCE	1,1,2,2-Tetrachloro ethane (ug/l)	Toluene (ug/l)	2-Butanone (ug/l) MEK
SW084	Jun-88	U	U	NR	U	U	U	15	U	U	U	U
	Apr-89	U	14	U	14	U	U	28	U	U	U	U
	Apr-89	U	10	U	11	U	U	35	U	U	U	U
	May-89	2J	U	U	2J	U	U	21	U	U	U	U
	May-89	U	110	U	U	U	U	20	U	U	U	U
	Jun-89	U	2J	U	6	U	U	100	U	U	U	U
	Jul-89	6	1JB	U	U	U	U	5	U	U	U	U
	Sep-89	4JB	27	15	5	U	U	65	3J	U	U	U
	Nov-89	6	U	U	U	U	U	3J	U	U	U	U
	Dec-89	6	8J	U	U	U	U	3J	U	U	U	4J
SW085	Jul-88	U	U	NR	U	U	U	U	U	U	U	U
	Apr-89	DRY										
	May-89	6	U	5U	U	U	U	U	U	U	U	U
	Jun-89	3J	27B	5U	U	U	U	U	U	U	9B	U
	Jul-89	4J	U	5U	U	U	U	U	U	U	U	U
	Aug-89	U	210B	25U	U	U	U	U	U	U	U	U
	Sep-89	U	U	5U	U	U	U	U	U	U	U	U
	Nov-89	DRY										
	Dec-89	DRY										
	Jan-90	DRY										

NOTES:
1) SEE FIGURE 10 FOR MONITORING SITE LOCATIONS
2) U = BELOW DETECTION LIMIT
3) J = DETECTED BELOW THE DETECTION LIMIT
4) B = DETECTED IN THE BLANK
5) THESE DATA WERE OBTAINED FROM THE RFP RFEDS DATABASE
6) SHADED PARAMETERS ARE INCLUDED ON FIGURE 14

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TABLE 9 (con't)
CONCENTRATIONS OF SELECTED VOCs IN SURFACE WATER
SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

Station Number	Sample Date	Methylene Chloride (ug/l) CH2CL2	Acetone (ug/l) (CH3)2CO	Total-1,2-Dichloro ethene (ug/l)	Tri-chloro-methane (ug/l)	1,2-Di-chloro-Ethane (ug/l)	1,1,1-Tri Chloro ethane (ug/l) TCA	Carbon Tetra Chloride (ug/l) CCl4	Trichloro ethene (ug/l) TCE	1,1,2,2-Tetrachloro ethane (ug/l)	Toluene (ug/l)	2-Butanone (ug/l) MEK
SW086	Jul-88	U	4J	NR	U	U	2J	3J	U	U	U	U
	Apr-89	U	5J	U	2J	U	U	21	U	U	U	U
	May-89	2J	U	U	U	U	U	5	U	U	U	U
	Jun-89	U	2J	U	4J	U	U	45	U	U	U	U
	Jul-89	2J	7B	U	U	U	U	5	U	U	U	U
	Sep-89	5B	U	7	6	U	U	64	2J	U	U	U
	Nov-89	6B	U	U	U	U	U	U	U	U	U	U
	Dec-89	6	11	U	U	U	U	1J	U	U	U	4J
SW087	Jul-88	U	U	U	U	U	U	U	U	U	U	U
	Jun-89	2J	16B	U	U	U	U	U	U	U	U	U
	Aug-89	2JB	140	U	U	U	U	4J	3JB	U	U	U
	Sep-89	U	U	U	U	U	U	2J	U	U	U	U
	Nov-89	7B	U	U	U	U	U	U	U	U	U	U
	Dec-89	U	8J	U	U	U	U	U	U	U	U	U
SW088	Jul-88	2J	U	NR	U	U	U	U	U	U	2J	U
	Jun-89	U	U	U	U	U	U	37	6	U	U	U
	Aug-89	6B	19B	U	4J	U	U	3J	2J	U	U	U
	Aug-89	U	180	U	U	U	U	U	U	U	U	U
	Aug-89	U	21B	U	U	U	U	U	U	U	U	U
	Sep-89	7B	U	U	U	U	U	U	U	U	U	U
	Nov-89	U	10	U	U	U	U	U	U	U	U	U
	Dec-89	U	U	U	U	U	U	2J	U	U	U	U

TABLE 9 (con't)
CONCENTRATIONS OF SELECTED VOCs IN SURFACE WATER
SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

Station Number	Sample Date	Methylene Chloride (ug/l) CH2CL2	Acetone (ug/l) (CH3)2CO	Total-1,2-Dichloro ethene (ug/l)	Tri-chloro methane (ug/l)	1,2-Di-chloro-Ethane (ug/l)	1,1,1-Tri Chloro ethane (ug/l) TCA	Carbon Tetra Chloride (ug/l) CCl4	Trichloro ethene (ug/l) TCE	1,1,2,2-Tetrachloro ethane (ug/l)	Toluene (ug/l)	2-Butanoı (ug/l) MEK
SW089	Jul-88	2JB	U	NR	2J	1J	U	U	3J	U	U	U
	Jun-89	1J	19B	2J	4J	U	U	U	3J	U	U	U
	Jul-90	7B	9JB	U	2J	U	U	U	1J	U	U	U
	Aug-89	U	970B	U	U	U	U	U	U	U	U	U
	Sep-89	U	U	U	U	U	U	U	U	440	U	U
	Nov-89	6B	8JB	U	1J	U	U	U	1J	U	U	U
	Dec-89	DRY										
SW090	Jul-99	2JB	U	NR	U	U	U	U	U	U	U	U
	Jun-89	2J	16	U	U	U	U	U	U	U	U	2J
	Jul-89	5B	10B	U	U	U	U	U	U	U	2J	U
	Aug-89	U	110B	U	U	U	U	U	U	U	U	U
	Sep-89	U	U	U	U	U	U	U	U	240	U	U
	Nov-89	4JB	35	U	U	U	U	U	U	U	U	U
	Dec-89	3J	U	U	U	U	U	U	U	U	U	U
	Dec-89	2J	U	U	U	U	U	U	U	U	U	U

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TABLE 9 (con't)
CONCENTRATIONS OF SELECTED VOCs IN SURFACE WATER
SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

Station Number	Sample Date	Methylene Chloride (ug/l) CH2CL2	Acetone (ug/l) (CH3)2CO	Total-1,2-Dichloro ethene (ug/l)	Tri-chloro-methane (ug/l)	1,2-Di-chloro-Ethane (ug/l)	1,1,1-Tri Chloro ethane (ug/l) TCA	Carbon Tetra Chloride (ug/l) CCl4	Trichloro ethene (ug/l) TCE	1,1,2,2-Tetrachloro ethane (ug/l)	Toluene (ug/l)	2-Butanone (ug/l) MEK
SW091	Jul-88	U	2JB	U	NR	U	U	U	U	U	U	U
	Mar-89	U	U	U	U	U	U	U	U	U	U	U
	May-89	U	U	U	U	U	U	U	U	U	U	U
	Jun-89	U	U	U	U	U	U	U	U	U	U	U
	Jul-89	U	U	U	U	U	U	U	U	U	U	U
	Aug-89	U	U	U	U	U	U	U	U	U	U	U
	Sep-89	U	U	U	U	U	U	U	U	U	U	U
	Oct-89	U	U	U	U	U	U	U	U	U	U	U
	Nov-89	U	U	U	U	U	U	U	U	U	U	U
	Dec-89	U	U	U	U	U	U	U	U	U	U	U
	Jan-90	U	U	U	U	U	U	U	U	U	U	U
	Feb-90	U	U	U	U	U	U	U	U	U	U	U
SW094	Jul-88	U	U	NR	U	U	U	U	U	U	U	U
	Jul-88	U	U	NR	U	U	U	U	U	U	U	U
	Mar-89	5B	U	U	U	U	U	12	4J	U	U	U
	Mar-89	4JB	U	U	2J	U	U	11	4J	U	U	U
	Jun-89	3JB	21B	U	2J	U	U	2J	4J	U	U	4J
	Jul-89	10B	11B	U	U	U	U	U	2J	U	U	U
	Jul-89	2JB	7JB	U	U	U	U	U	2J	U	U	U
	Aug-89	6B	U	U	2J	U	U	2J	4J	U	U	U
	Sep-89	U	U	U	U	U	U	U	U	U	U	U
	Sep-89	U	U	U	U	U	U	U	U	U	U	U
	Oct-89	3JB	U	U	2J	U	U	U	U	U	U	U
	Nov-89	U	U	U	U	U	U	U	U	U	U	U
	Dec-89	U	U	U	U	U	U	U	U	U	U	U

TABLE 9 (con't)
CONCENTRATIONS OF SELECTED VOCs IN SURFACE WATER
SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

Station Number	Sample Date	Methylene Chloride (ug/l) CH2CL2	Acetone (ug/l) (CH3)2CO	Total-1,2-Dichloro ethene (ug/l)	Tri-chloro-methane (ug/l)	1,2-Di-chloro-Ethane (ug/l)	1,1,1-Tri Chloro ethane (ug/l) TCA	Carbon Tetra Chloride (ug/l) CCl4	Trichloro ethene (ug/l) TCE	1,1,2,2-Tetrachloro ethane (ug/l)	Toluene (ug/l)	2-Butanone (ug/l) MEK
SW095	Jul-88	1J	U	NR	2J	U	U	1J	U	U	U	U
	Mar-89	5B	U	U	2J	U	U	11	4J	U	U	U
	Jun-89	2JB	7JB	U	1J	U	U	1J	3J	U	U	U
	Jul-89	4JB	8JB	U	U	U	U	U	2J	U	U	U
	Aug-89	2JB	80	U	2J	U	U	2J	4J	U	U	U
	Oct-89	U	U	U	U	U	U	U	U	U	U	U
	Nov-89	U	U	U	U	U	U	U	U	U	U	U
	Dec-89	U	U	U	U	U	U	U	U	U	U	U
SW102	Jul-88	1JB	U	NR	1J	U	U	U	U	U	U	U
	Apr-89	DRY										
	May-89	DRY										
	Jun-89	DRY										
	Jul-89	DRY										
	Aug-89	DRY										
	Oct-89	DRY										
	Oct-89	DRY										
	Jan-89	DRY										
	Dec-89	DRY										
	Jan-90	DRY										
	Feb-90	DRY										

TABLE 9 (con't)
CONCENTRATIONS OF SELECTED VOCs IN SURFACE WATER
SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

Station Number	Sample Date	Methylene Chloride (ug/l) CH2CL2	Acetone (ug/l) (CH3)2CO	Total-1,2-Dichloro ethene (ug/l)	Tri-chloro-methane (ug/l)	1,2-Di-chloro-Ethane (ug/l)	1,1,1-Tri Cholor ethane (ug/l) TCA	Carbon Tetra Chloride (ug/l) CCl4	Trichloro ethene (ug/l) TCE	1,1,2,2-Tetrachloro ethane (ug/l)	Toluene (ug/l)	2-Butan (ug/l) MEK
SW105	Jul-99	2JB	U	NR	U	U	U	U	U	U	U	U
	Jul-99	2JB	U	NR	2J	U	U	U	U	U	U	U
	Jun-89	U	U	U	U	U	U	U	U	U	U	U
	Jul-89	4JB	20B	U	U	U	U	U	1J	U	U	U
	Jul-89	2JB	12B	U	U	U	U	U	U	U	U	U
	Aug-89	U	64	U	U	U	U	U	U	U	U	U
	Aug-89	4JB	100	U	U	U	U	U	1J	U	U	U
	Sep-89	10	33	U	U	U	U	U	U	U	U	U
	Nov-89	7B	U	U	U	U	U	U	U	U	U	U
	Dec-89	2J	5J	U	U	U	U	U	U	U	U	4J
SW106	Jun-89	U	U	U	U	U	U	U	U	U	U	U
	Jul-89	DRY										
	Aug-89	DRY										
	Sep-89	DRY										
	Oct-89	DRY										
	Nov-89	DRY										
	Dec-89	DRY										
	Jan-90	DRY										
	Feb-90	DRY										

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TABLE 10
CONCENTRATIONS OF SELECTED VOCs IN GROUNDWATER
SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

Station Number	Sample Date	Methylene Chloride (ug/l) CH2CL2	Acetone (ug/l) (CH3)2CO	Total-1,2-Dichloro-ethene (ug/l)	Tri-Chloro-methane (ug/l)	1,2-Di-chloro-ethane (ug/l)	1,1,1-Tri-chloro-ethane (ug/l) TCA	Carbon tetra-chloride (ug/l) CCl4	Trichloro-ethene (ug/l) TCE	Tetra-chloro-ethene (ug/l)	Toluene (ug/l)	2-Butanone (ug/l) MEK
1786	Mar-88	U	U	U	U	U	U	U	U	3J	U	U
	May-88	U	U	U	U	U	U	U	U	U	U	U
	Aug-88	7J	U	U	U	U	U	U	U	U	U	U
	Nov-88	5JB	U	U	2JB	U	U	U	2J	U	4JB	U
	Feb-89	6	U	U	U	U	U	U	U	U	U	U
	May-89	U	U	U	U	U	U	U	22	U	U	U
	Sep-89	U	U	U	U	U	U	U	U	U	U	U
	Dec-89	U	U	U	U	U	U	U	U	U	U	U
260	Jan-88	8	13	U	9	U	U	7	U	U	U	6J
	Mar-88	17	U	U	U	U	U	U	U	U	U	U
	May-88	U	U	U	U	U	U	U	U	U	U	U
	Sep-88	11	U	U	U	U	U	U	U	U	U	U
	Dec-88	4JB	U	U	4JB	U	U	U	U	U	4JB	U
	Feb-89	U	U	U	U	U	U	U	U	U	U	U
	May-89	U	U	U	4J	U	U	U	U	U	U	U
	Nov-89	U	U	U	U	U	U	U	U	U	U	U

NOTES:
1) SEE FIGURE 11 FOR WELL LOCATIONS
2) THESE DATA WERE OBTAINED FROM THE RPF RFEDS DATABASE. VALUES PRESENTED ON THIS TABLE ARE IDENTICAL TO THOSE PROVIDED BY RFP.
3) U = BELOW DETECTION LIMIT.
4) J = DETECTED BELOW THE DETECTION LIMIT.
5) B = DETECTED IN THE BLANK.
6) SHADED PARAMETERS ARE INCLUDED ON FIGURE 15.

TABLE 10 (con't)
CONCENTRATIONS OF SELECTED VOCs IN GROUNDWATER
SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY

Station Number	Sample Date	Methylene Chloride (ug/l) CH2CL2	Acetone (ug/l) (CH3)2CO	Total-1,2-Dichloro-ethene (ug/l)	Tri-chloro-methane (ug/l)	1,2-Di-chloro-ethane (ug/l)	1,1,1-Tri-chloro-ethane (ug/l) TCA	Carbon tetra-chloride (ug/l) CC14	Trichloro-ethene (ug/l) TCE	Tetra-chloro-ethene (ug/l)	Toluene (ug/l)	2-Butanone (ug/l) MEK
3086	Jan-88	U	U	U	U	U	U	U	U	U	U	U
	Jan-88	14	U	U	U	U	U	U	U	U	U	U
	Mar-88	U	U	U	U	U	U	U	U	U	U	U
	May-88	17	U	U	U	U	U	U	U	4J	U	U
	Sep-88	4JB	U	U	U	U	U	U	U	U	U	U
	Dec-88	U	U	U	3JB	U	U	U	U	2J	3JB	U
	Mar-89	U	U	U	U	U	U	U	1J	1J	U	U
	May-89	U	U	U	3J	U	U	U	U	U	U	U
	Sep-89	U	U	U	U	U	U	U	U	U	U	U
	Sep-89	U	U	U	U	U	U	U	U	U	U	U
	Nov-89	U	U	U	U	U	U	U	U	2J	U	U
	Nov-89	13B	U	U	U	U	U	U	U	2J	U	U
P208989	Sep-89	DATA NOT AVAILABLE										
P209589	Sep-89	U	7B	U	U	U	U	U	U	U	U	U
P209489	Sep-89	DATA NOT AVAILABLE										
3286	Mar-88	17	U	U	U	U	U	U	U	U	U	U
	May-88	U	U	U	U	U	U	U	U	U	U	U
	Sep-88	18	U	U	U	U	U	U	U	U	U	U
	Dec-88	3JB	U	U	2JB	U	U	U	U	U	4JB	U
	Mar-89	U	U	U	U	U	U	U	U	U	U	U
	May-89	U	U	U	U	U	U	U	5	U	U	U
	Nov-89	DATA NOT AVAILABLE										

TABLE 10 (con't)
CONCENTRATIONS OF SELECTED VOCs IN GROUNDWATER
SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY
CONTINUED

Station Number	Sample Date	Methylene Chloride (ug/l) CH2CL2	Acetone (ug/l) (CH3)2CO	Total-1,2-Dichloro ethene (ug/l)	Tri-chloro-methane (ug/l)	1,2-Di-chloro-ethane (ug/l)	1,1,1-Tri-chloro-ethane (ug/l) TCA	Carbon tetra-chloride (ug/l) CCl4	Trichloro-ethene (ug/l) TCE	Tetra-chloro-ethene (ug/l)	Toluene (ug/l)	2-Butanone (ug/l) MEK
P208889	Sep-89	5B	7J	U	2J	U	U	U	U	U	U	U
3987BR	Mar-88	13	U	U	U	U	U	U	U	U	U	U
	May-88	U	U	U	U	U	U	U	U	3	U	U
	Sep-88	1	U	U	U	U	U	U	U	U	U	U
	Nov-88	3JB	U	U	2JB	U	U	U	U	U	3JB	U
	Mar-89	U	U	U	U	U	U	U	U	U	U	U
	May-89	U	U	U	U	U	U	U	U	U	U	U
	Nov-89	U	U	U	U	U	U	U	U	U	U	U

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the ITPH system area. The concentration of TDS (and NO_3/NO_2) fluctuated by an order of magnitude with each sampling episode. Based on the available data, there appears to be an inverse relationship of precipitation and concentration; however, sampling has not been frequent enough to conclusively substantiate this relationship. It could be expected that as surface water and groundwater volumes increase, the system may become more dilute, thus indicating a relative decrease in concentration. Conversely, as the ground dries, relative levels of contaminants appear more highly concentrated. This relationship is further supported by the apparent immobility of the inorganic contaminants in the clay-rich material. Large molecule inorganic constituents are not readily flushed through low permeable clay. The mobility of contaminants through sandstone is significantly greater and can be seen by the lower concentrations of TDS in the samples from monitoring sites SW085 and SW102, which are located in nearby sandstones.

Water collected from site SW106 exhibits levels of inorganic constituents only slightly above background. Water collected from sites SW090, SW087, SW089, and SW105 have concentrations several orders of magnitude greater. Samples collected from the two deep wells (3286 and 3987BR) have concentrations below background for inorganic constituents; whereas, wells with screened intervals above 5930 feet above MSL have concentrations greater than background for the geologic unit. The drains related to sites SW090 and SW087 are approximately four feet below the surface at a level of approximately 5940 feet above MSL. Groundwater infiltrates into the drain system contributing to the concentrations detected at the surface water monitoring stations (specifically sites SW087 and SW094). The old Sump Number 2 (site SW089) has been observed to overflow during precipitation events. The relative contribution of contamination detected at the surface water monitoring stations is a function of communication between surface water and groundwater at specific monitoring locations.

Discrete gross alpha activity in the ITPH system has been greatest in water collected from site SW090 although activity is also consistently high in water collected from site SW089. Water collected from sites SW087 and SW085 have been analyzed with higher than background gross alpha activity. Conversely, water collected from sites SW106 and SW105 have been monitored with considerably lower gross alpha activity. Radionuclides in the groundwater are low as well. The pH in the samples from site SW090 ranges from 4.6 to 7.9 and represents the greatest acidity in the ITPH system. Generally, VOCs have not been detected in this area in the groundwater except for trace amounts of acetone and carbon tetrachloride. VOCs have been detected in the samples from sites SW090 and SW087.

The East Extension of the ITPH accounts for the high levels of inorganic compounds. The surficial materials in the area between the ITPH extension and the solar ponds appear to be primarily contaminated with inorganic constituents and gross alpha activity.

4.2.3 West Extension to ITPH

Surface monitoring site SW088 is located in the west invert to the manhole on the ITPH extension. Samples from this station are taken as composite samples from the manhole due to the difficulty in obtaining a sample from the drain as it enters the manhole. The concentrations represent the combined influent from east and west drain inverts. Volumetric variation make it difficult to estimate the proportion each drain contributes to the analytical results. Therefore, the exact contaminant contribution of the west extension to the ITPH is unknown. Site SW088 represents the surface water and shallow groundwater which is intercepted as it travels downgradient and water in the ITPH system coming from the east and west portions of the ITPH extension. There are no groundwater monitoring wells in the area that would provide information on contamination in the immediate area. The samples collected from site SW088 indicate a dilution of concentrations of VOCs, inorganic constituents, and radionuclides compared to water collected from site SW086.

4.2.4 East Inflow to ITPH

Site SW094 is the east invert into the ITPH wet-well. There are no surface water or groundwater monitoring sites in the east portion of the drain system that allow for analysis of water prior to its collection by the ITPH system. The water entering the east invert represents predominantly groundwater flow collected by the drain system. Samples collected from site SW094 reveals slightly elevated levels of carbon tetrachloride and radionuclides and somewhat elevated levels of TDS and NO_3/NO_2. The results of water sampled from well 1786, located near North Walnut Creek downhill from the ITPH, indicate high levels of TDS and NO_3/NO_2 as well as elevated levels of radionuclides. Well 1786 does not appear to have VOCs present in its groundwater.

4.2.5 West Inflow to ITPH

Site SW095 is located in the ITPH wet-well. The water in the wet-well is a composite of flow from the entire ITPH system. Because of its inaccessibility, the flow from the west invert is not sampled. Site SW094 is located at the east invert to the ITPH wet-well which is more readily accessible. Site SW095 represents water transferred from sites SW087 and SW088 along with all surface water and groundwater intercepted by the western portions of the drain system. Sampling results indicate virtually identical levels of constituents from site SW095 to water collected from site SW094. Although water from the west invert is not directly sampled, the similarity of SW095 and SW094 chemical analyses indicates both inflows are relatively similar in chemical make-up.

4.3 RECOMMENDATIONS/CONCLUSIONS

The following recommendations are made with respect to improving surface water and groundwater quality in the solar pond area and the ITPH system.

1. Based upon the available data, the greatest concentrations of VOCs are located in the west side of the drain system. By preventing water from the footing drains and the West Collector from entering the ITPH system at the west collector, it is thought that concentrations of VOCs can be reduced to levels that are below action levels. The considerably smaller volume of water from the footing drains

that is contaminated by VOCs can be more efficiently remediated using methods other than the ITPH.

2. Inorganic compound contamination is greatest in the surface water directly north of Solar Pond 207B-North and in the shallow groundwater in the solar pond area. Inorganic contamination is greater in the groundwater underlying North Walnut Creek than at the ITPH. An interceptor/extraction well system designed and implemented directly north of Solar Pond 207B-North could be efficiently used to characterize the groundwater quality and efficiently remove contaminated groundwater. As a first step, it is suggested that monitoring well P208989 be converted to a production well in order to reduce the migration of contaminated groundwater away from the solar ponds. This well is a 4-inch inner diameter well in a 7.25-inch protective casing and is screened in Sandstone Number 1 from approximately 5947 to 5938 above MSL. Alternatively, a new well could be drilled and completed as a production well closer to the area of greatest water contamination (near site SW090).

3. Water quality in the solar pond area should continue to be monitored following any modifications of the system made as a result of recommendations made in this or other studies. The response of water quality to any of these potential changes will provide additional information relevant to the design and effectiveness of remedial measures.

4. Modifications to the ITPH system are expected to impact water quantity and, therefore, the relative concentrations of parameters of concern. However, the presence of these parameters is not expected to be altered due to the anticipated modifications.

5.0 WATER MANAGEMENT ALTERNATIVES

To date, the water collected by the ITPH system has been transferred to the solar ponds for storage and treatment. The RCRA/CERCLA activities that will have an impact on the solar ponds will ultimately result in the removal of sludges and pond liners and remediation of the solar pond area. Therefore, an alternative ITPH water management program should be identified.

This section of the report evaluates four ITPH water management alternatives. These evaluations are based upon the technical merits of treating the water in one manner as opposed to another. Regulatory issues will influence the selection of the final ITPH water management alternative. Water management alternatives for the ITPH water will be determined by the investigation, characterization, and remediation process described in the draft IAG. These alternatives may consist of both interim remedial actions and final remedial actions. Completion of the IAG process will determine regulatory and technical issues that will impact future management of the ITPH water.

As discussed in previous sections of this report, the ITPH flow has the following characteristics:

- Average annual flow of approximately 5.9 gpm (3,100,000 gallons per year).
- Maximum transfer flow rate by ITPH pumps of 100 gpm.
- Capable of pumping approximately 300,000 gallons in a two-day period in response to back-to-back precipitation events of approximately 20-year return frequency.
- Quality of flow is characterized by increased concentrations of:
    - radionuclides
    - nitrate
    - VOCs
    - total dissolved solids

A treatment capacity of approximately 5.9 gpm with surge capacity storage of approximately 1,000,000 gallons should be adequate for treatment of the flows from the ITPH system. Modifications of the existing ITPH system may influence the total required treatment capacity as well as the total required surge storage capacity. Therefore, the effect of all modifications should be closely monitored to determine the impact these modifications have on the overall ITPH system flows and water quality. It is possible for portions of the flow currently collected by the ITPH system to be treated separately.

Treatment alternatives for the ITPH system water proposed as a result of this study include: mechanical evaporation of the total flow; treatment at the Sanitary Treatment Plant (STP) of the total flow; ultraviolet light/peroxide treatment of the west collector flow along with STP treatment of the remainder of the flow; and reverse osmosis of the entire flow followed by mechanical evaporation of the rejected brine. The actual treatment option selected will depend in part upon the results of other studies that are a part of the Zero-Offsite Water-Discharge Study.

The final treatment option selected will also depend on the results of the ongoing solar pond investigation and characterization activities that are part of the draft IAG. It should be noted that the regulatory status of the ITPH flows are also a consideration in selection of appropriate treatment options for the waste. The regulatory status of the waste and the ramifications of treatment for any one of the options may make selection of that treatment option a regulatory impossibility. The treatment options discussed in this report are all considered to be technically feasible treatment alternatives at this time. Any long-term treatment option pursued by the RFP for the ITPH wastes should be discussed and receive approval from CDH and EPA prior to the implementation of that treatment option.

A matrix was used to compare pertinent concerns and identify the most desirable treatment option. The matrix considers eleven factors, each of which is assigned a weighting factor of one to ten. Each treatment option was assigned a score from one to five for each factor. The scores of each treatment option reflect the relative desirability of the treatment option. A score of one is least desirable and a score of five is most desirable. The treatment option with the highest overall score is the desired treatment option. The weighting factor reflects the perceived importance of the factor in final selection of a treatment alternative. A weighting factor of one implies a less important consideration and a weighting factor of ten implies a very important consideration. These weighting factors will influence the Zero-Offsite Water-Discharge Study and were selected by a committee of cognizant DOE and EG&G personnel.

5.1 TREATMENT BY MECHANICAL EVAPORATION

The entire ITPH flow is suitable for treatment in mechanical evaporators. These evaporators could be similar to the Vapor Compression Evaporators currently being evaluated for use on existing solar pond water. The evaporated water would be recondensed and recycled at the RFP. Implementation of this option would require a surge storage tank for collection of ITPH flows during particularly wet periods of the year, as well as purchase and installation of mechanical evaporators. It is anticipated that these evaporators would be constructed near Building 910, southeast of the solar ponds. All rejected brine from the evaporators would be expected to be solidified at the Building 374 Evaporator. The total anticipated costs (capital plus operation and maintenance) for this treatment alternative are presented in Table 11, and the summary evaluation matrix for all alternatives is presented in Table 12. The capital cost breakdown for this alternative is:

Pump Station to Blg. 910 Area	$106,500
Force Main to Blg. 910 Area	25,500
Evaporators	900,000
Surge Tank	629,100
TOTAL	$1,661,100.

TABLE 11

ESTIMATED TREATMENT ALTERNATIVE COSTS

	ALTERNATIVE	CAPITAL COST (1990 $)	O&M* COST ($/year)	MATRIX RANK
1)	Mechanical Evaporation of all Flow	1,750,400	291,600	1
2)	Sewage Treatment Plant Treatment of all Flow	853,400	4,100	4
3)	Separate Flow Treatment U.V. Peroxide and Sewage Treatment Plant	893,900	86,100	3
4)	Reverse Osmosis and Mechanical Evaporation of all Flow	1,067,800	264,300	2

*O&M = Operation and Maintenance

TABLE 12
EVALUATION MATRIX

EVALUATION FACTORS*	WEIGHTING FACTOR	ALT 1 MECHANICAL EVAPORATION		ALT 2 SEWAGE TREATMENT PLANT		ALT 3 SEPARATE TREATMENT		ALT 4 REVERSE OSMOSIS & MECHANICAL EVAPORATION	
		S	W	S	W	S	W	S	W
CONTROLLED DISCHARGE	10	5	50	1	10	2	20	5	50
WASTE GENERATION	7	2	14	3	21	4	28	2	14
RISKS	8	4	32	3	24	2	16	3	24
COST	6	2	12	5	30	4	24	3	18
DESIGN AND CONSTRUCTION SCHEDULE	6	5	30	3	18	3	18	2	12
FLEXIBILITY	8	3	24	2	16	3	24	3	24
WATER RIGHTS	5	3	15	3	15	3	15	3	15
AIR EMISSIONS	10	5	50	2	20	4	40	5	50
WETLANDS/T&E SPECIES	10	3	30	3	30	3	30	3	30
IHSS (SWMU)	10	4	40	3	30	2	20	2	20
PUBLIC ACCEPTABILITY	8	5	40	2	16	3	24	5	40
TOTALS			337		230		252		297
RANK			1		4		3		2

S = SCORE; W = WEIGHTED SCORE = SCORE x WEIGHTING FACTOR

* Defined on the following pages

EVALUATION FACTORS - DEFINITIONS

COST:	1 = High Construction, O, M, & R Cost 5 = Low Construction, O, M, & R Cost
FLEXIBILITY:	1 = Small Ability to Respond to Changing Conditions 5 = Large Ability to Respond to Changing Conditions
RISK:	1 = High Risk 5 = Low Risk
PUBLIC ACCEPTABILITY:	1 = Low Likelihood of Public Acceptability 5 = High Likelihood of Public Acceptability
WATER RIGHTS:	1 = High Water Rights Impact 5 = Low Water Rights Impact
DESIGN AND CONST. SCHEDULE:	1 = Total Schedule Greater Than 5 Years 5 = Total Schedule 1 Year or Less
IHSS (SWMU):	1 = IHSS Are Impacted 5 = No IHSS Are Impacted
WETLANDS/T&E:	1 = Wetlands/T&E Species Are Impacted 5 = No Wetlands/T&E Species Are Impacted
WASTE GENERATION:	1 = Large Quantity of Solid Waste 5 = Small Quantity of Solid Waste
AIR EMISSIONS:	1 = High Air Emissions 5 = Low Air Emissions
CONTROLLED DISCHARGE:	1 = High Potential for Controlled Downstream Discharge 5 = Low Potential for Controlled Downstream Discharge

Note: Score on a scale of 5 (best) through 1 (worst)

<u>CONTROLLED DISCHARGE:</u> Each alternative was considered for the quantity of water to be discharged. Alternatives 2 and 3 will require some discharge after treatment at the STP and consequently received low scores. Alternatives 1 and 4, which will reuse/recycle treated water, received a high score.

<u>WASTE GENERATION:</u> Solid waste generated from the treatment systems include salts and sludges. Treatment by Alternatives 1 and 4 will produce new solid wastes not currently generated. The STP treatment system already generates a solid waste and Alternatives 2 and 3 only increase that quantity slightly. Alternative 3, in which a portion of the waste will be sent to the STP is given the highest score because the portion sent to the UV/Peroxide unit will not produce solid waste.

<u>RISKS:</u> Risk was considered based on the volume of untreated liquid stored and transported to the appropriate treatment facility. Alternative 3 would necessitate the liquid be separated and sent to two holding facilities. This is considered to be of higher risk than the one holding facility the other alternatives would require. Alternative 1 is regarded as being the least risky since all the treatment units, including brine solidification, will be constructed in close proximity to the ITPH system and piping will be minimized.

COSTS:

Relative costs of the treatment alternatives were estimated based upon the anticipated conceptual design of the treatment facilities. Alternative 2 presents the greatest cost advantage because the STP system exists and is capable of accepting the volume of liquid produced by the ITPH system. This alternative will require a pump station, a surge tank, and a force main. Other alternatives will require these same components and additional equipment. Alternative 1 presents a cost disadvantage because of the cost of the construction of the evaporators and associated equipment.

DESIGN AND CONSTRUCTION SCHEDULE:

It is anticipated that Alternative 1 can be constructed and implemented within one year. Alternatives 2 and 3 may take more than one year to implement due to procedures and acquisition and are not as favorable as Alternative 1. The implementation schedule of Alternative 4 is unknown pending the outcome of Task 12 of the Zero-Offsite Water-Discharge Plan but is considered to require a greater amount of time than the other alternatives.

FLEXIBILITY:

The flexibility of the alternatives is about equal with the exception of Alternative 2. The use of the STP is somewhat less flexible because of the requirement of the denitrification system in this alternative.

WATER RIGHTS: None of the alternatives represents any greater or lesser impact on water rights.

AIR EMISSIONS: Alternatives 1 and 4 are contained units and prevent the release of any air emissions and are given the highest scores. Alternative 2 does not have a process specific to the treatment of volatile organic compounds and will probably result in some release to the atmosphere. Alternative 3 destroys the organics by the UV/Peroxide treatment system, preventing any release to the air.

WETLANDS/T&E SPECIES: None of the alternatives represents any greater or lesser impact on wetlands or threatened and endangered species.

IHSS (SWMU): The implementation of Alternative 1 will have the least degree of impact on IHSSs relative to the other options. Because of pipelines required by Alternatives 3 and 4 to transport liquid to Building 374, the risk of impact to IHSSs in the path of the pipeline is greater. Alternative 2 requires a pipeline of shorter length than Alternatives 3 and 4 and therefore has a lower score than Alternatives 3 and 4.

PUBLIC ACCEPTABILITY: Public health concerns are dependant on the release of products to the atmosphere and the potential for controlled discharges and the scoring of this category is the same as for Air Emissions.

This treatment option, although the most expensive, is the preferred treatment option with a total matrix score of 337. The factors of most importance in the selection of this treatment alternative as the most desirable are the factors of controlled discharge, design and construction schedule, air emissions, and public acceptability. This treatment option has an extremely small potential for offsite discharges of water because the evaporator units were designed to have adequate capacity for all anticipated flows. Further, the concentrated brine waste produced by the evaporators will be solidified at the evaporator units, again preventing the need for offsite discharges. Design and construction of these evaporator units has already begun, making this the treatment option that can come online first. Air emissions from these evaporators will be minimal because evaporated water flows are to be recondensed and the water reused. The public acceptability of this treatment option is also high since it is currently planned that there will be no offsite releases of any kind from this treatment option. In addition to the above, the risks associated with this option are also relatively low (i.e. have a high score) since the length of pipelines are minimized.

Additional Zero-Offsite Water-Discharge Studies are underway that have some bearing on this treatment alternative. Reuse of process water is being evaluated under Task 11; whereas, mechanical evaporators are being evaluated as a portion of Task 12 of the Zero-Offsite Water-Discharge Study.

5.2 TREATMENT THROUGH THE SEWAGE TREATMENT PLANT

The excess hydraulic capacity of the Sewage Treatment Plant (STP) is sufficient to accept and treat the entire ITPH transfer flows. Treatment through the STP would require a new force main to connect the ITPH pump house with the STP headworks (Building 990), as well as a surge storage tank to contain ITPH flows during periods of wet weather when great amounts of transferred flow are expected. The surge tank would be necessary at these times to decrease the possibility of flushing the biomass out of the STP. Further, since the ITPH waste is high in nitrates, this option is not feasible until the STP is modified to provide for denitrification of wastewaters. The current understanding is that the STP will be modified to provide for denitrification in the near future. The treated effluent would be discharged offsite. The anticipated costs for this treatment alternative are presented in Table 11, and the summary evaluation matrix is presented in Table 12. The capital cost breakdown for this option is:

Pump Station to STP Headworks	$106,500
Force Main to STP Headworks	28,900
Surge Tank	718,400
TOTAL	$853,400.

This treatment option, although the least expensive, is the least preferred treatment option with a total matrix score of 230. The principal reasons for the low score of this treatment alternative is that it necessitates offsite water releases, currently the STP releases to Pond B-3, and has the potential for offsite air releases. Therefore, the matrix scores for controlled discharge, air emissions, and public acceptability are all low. Additionally, the score for flexibility is low since this treatment alternative provides relatively little additional flexibility to the RFP.

The feasibility of treatment through the STP will be further defined after completion of Task 10, Sewage Treatment Plant Evaluation. Task 10 will be of particular importance in re-evaluating the relative rankings of these treatment options if complete recycling of STP effluent is recommended. Complete recycling of the effluent would probably modify the scores for controlled discharge, air emissions, and public acceptability. However, given the regulatory status of the ITPH water, if the ITPH water is treated through the STP, it may be necessary to delist the effluent from the STP. This delisting specifically concerns the lists of hazardous waste identified in the RCRA regulations. These delisting activities may be both time intensive and costly, and will need to be addressed in any re-evaluation of treatment options for the ITPH water. The treatment and release of ITPH water from the STP may also require modification of the Rocky Flats Plant National Pollutant Discharge Elimination System (NPDES) Permit which is undergoing renewal.

5.3 SEPARATE TREATMENT, ULTRAVIOLET LIGHT (UV)/PEROXIDE, AND SEWAGE TREATMENT PLANT

Interim remedial actions at the Building 881 Hillside will involve the use of a UV/Peroxide treatment system for the complete destruction of contaminated groundwaters collected at the Building 881 Hillside. These waters are similar to those collected at the West Collector of the ITPH system extension. The flows from the West Collector are characterized by relatively low nitrates but relatively high concentrations of VOCs. Therefore, treatment of the West Collector flow, approximately 1.3 gpm (approximately 683,000 gallons per year) through the UV/Peroxide system would provide for complete destruction of the VOCs contained in the West Collector flow and would allow for treatment of the remainder of the ITPH system flow by the STP. Implementation of this treatment option would require two pump stations and force mains, one from the West Collector to the Building 881 Hillside treatment unit, and one from the ITPH wet-well to the STP headworks (Building 990). This treatment option would also require the construction of a surge storage tank to contain ITPH flows during periods of wet weather. The surge tank would be necessary at these times in order to decrease the possibility of flushing the biomass out of the STP. This option is also not feasible until the STP is modified to provide for denitrification of wastewaters. It is the current understanding that modification of the STP to provide for denitrification will proceed in the near future. The treated effluent is anticipated to be managed in a manner similar to the current effluent management, offsite discharge. The anticipated costs for this treatment alternative are presented in Table 11, and the summary evaluation matrix is presented in Table 12. The capital cost breakdown for this option is:

Pump Station to STP Headworks	$106,500
Force Main to STP Headworks	28,900
Surge Tank	718,400
Pump Station: West Collector to 881 Hillside Area	10,700
Force Main: West Collector to 881 Hillside Area	29,400
TOTAL	$893,900.

This treatment option is ranked third with a total matrix score of 252. The principal reasons for the relatively low score of this treatment option is that this treatment option necessitates offsite water releases (the STP currently releases to Pond B-3), has long force mains associated with it, and has the potential to impact IHSSs. Therefore, the matrix scores for controlled discharge, risks, and potential for IHSS impacts are all low.

The feasibility of treatment through the STP will be further defined after completion of Task 10, Sewage Treatment Plant Evaluation. Many of the same concerns that apply to STP treatment of ITPH water that were discussed in Section 5.2 of this report also apply this treatment option. However, separate treatment of the West Collector flows and the remainder of the ITPH flows may make delisting activities easier. Delisting benefits of separating the flows, if any, cannot be identified until after the flows are separated and the separate flows are characterized. The treatment and release of ITPH water from the STP may require modification of the RFP NPDES Permit which is undergoing renewal.

5.4 REVERSE OSMOSIS AND MECHANICAL EVAPORATOR

The entire flow of the ITPH system is suitable for treatment by reverse osmosis followed by mechanical evaporation of the rejected brine in Building 374. Implementation of this treatment option would require a new pump station and force main from the ITPH pump house to the reverse osmosis units. It is currently expected that the reverse osmosis units would be constructed in the Building 910 area immediately southeast of the solar ponds. From the Building 910 area the rejected brine would be pumped to Building 374 for evaporation and solidification. In common with all other treatment options, this option requires a surge storage tank for containment of flows during extremely wet periods. The anticipated costs for this treatment alternative are presented in Table 11, and the summary evaluation matrix is presented in Table 12. The capital cost breakdown for this option is:

Pump Station to Blg. 910 Area	$106,500
Force Main to Blg. 910 Area	25,500
Reverse Osmosis Unit	170,000
Surge Tank	718,400
Pump Station from Blg. 910 to Blg. 374	10,700
Force Main from Blg. 910 to Blg. 374	36,700
TOTAL	$1,167,800.

This treatment option is the second most preferred option of the four options studied with an overall matrix score of 297. The direct reasons for the relatively high score for this treatment option include the lack of offsite emissions of water or air, as well as the high public acceptability of the option. The principal differences between this option and the complete evaporation of all flows are that the implementation of this option would take longer, and the risks and potential IHSS impacts from this alternative would also be greater. This option would take longer to bring online simply because engineering activities related to it have not started, whereas the engineering activities for total evaporation have begun. The differences in risks and IHSS impacts are due to the need for more piping in this option.

6.0 ACKNOWLEDGEMENTS

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A.C. Shah, DOE-E&G
A.D. Berzins, EG&G - ER/EMAD
E.W. Mende, EG&G - ER/CWAD
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C. Rose, ER/CWAD consultant
R.T. Ogg, EG&G - ER/RP
F. Walker, EG&G - FPM

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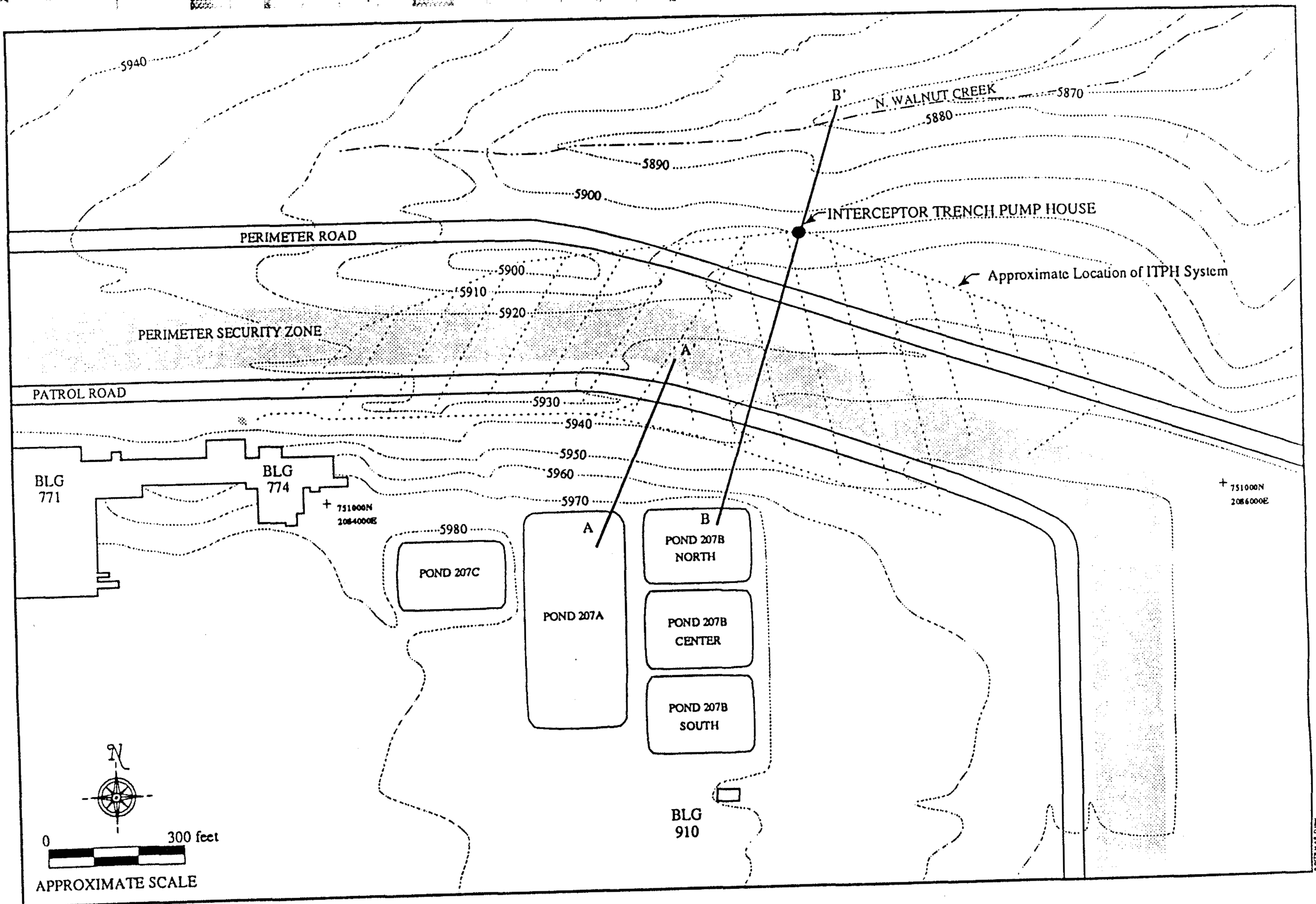
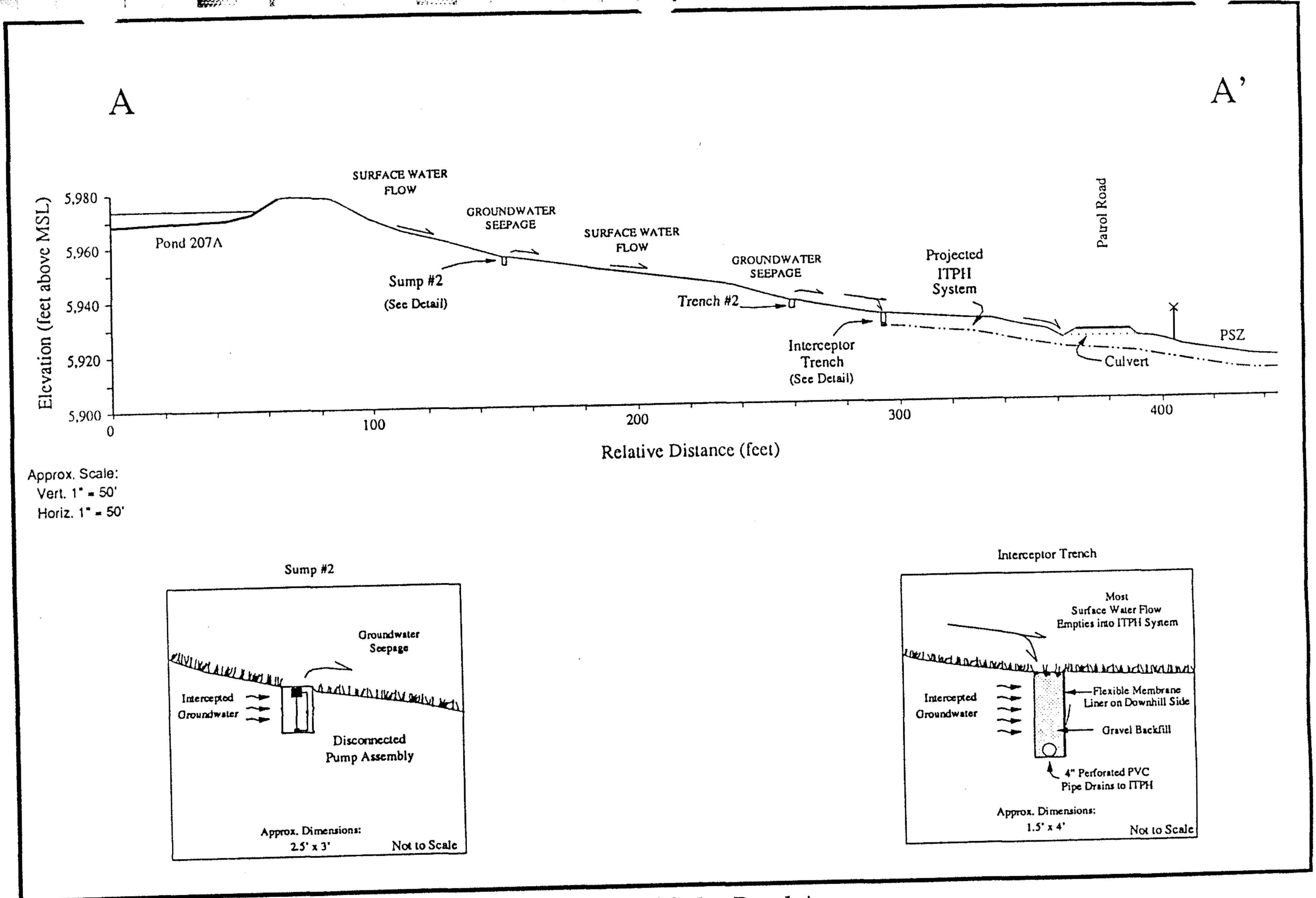


Solar Pond Interceptor Trench System Area

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 1

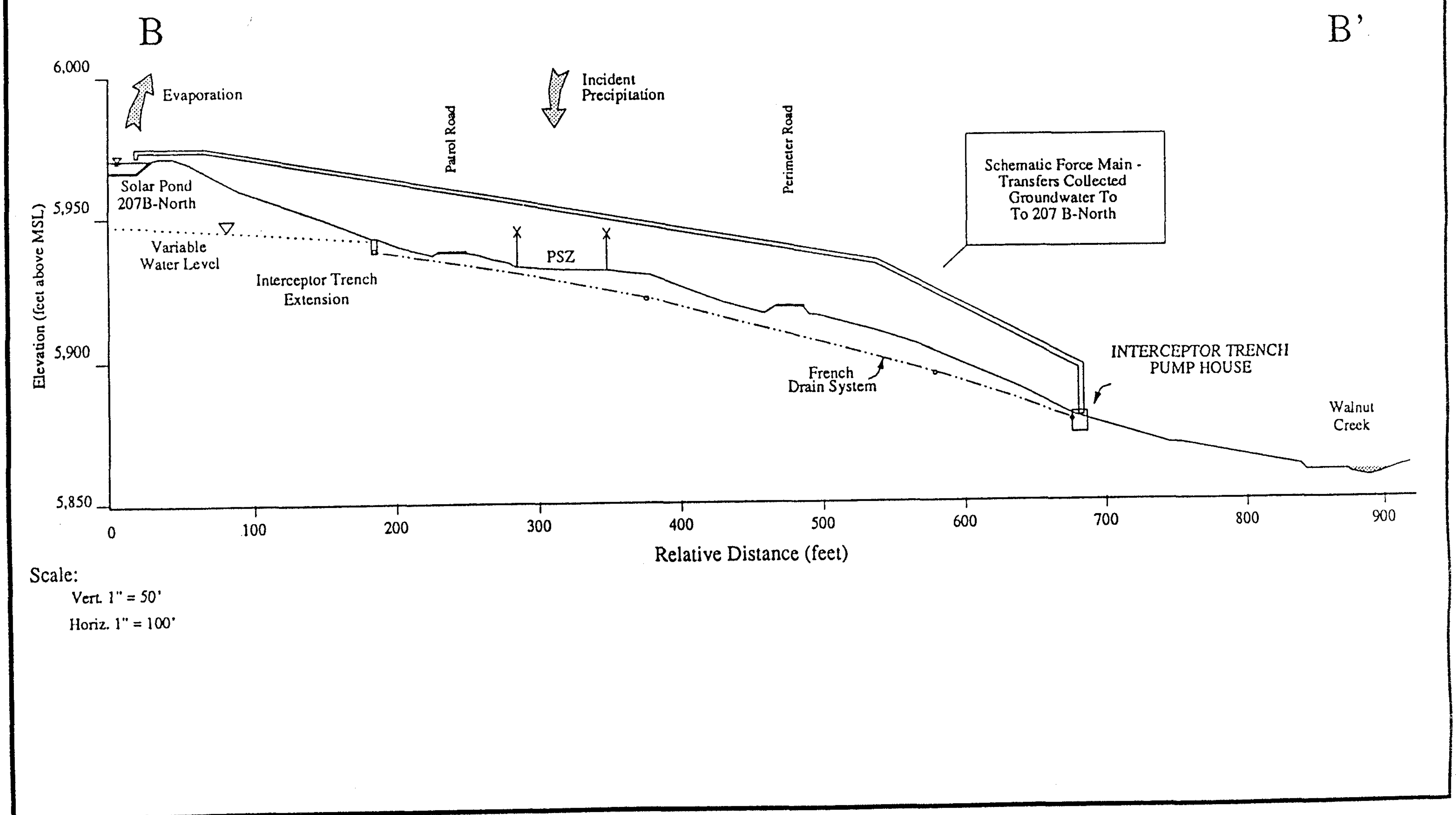


Cross Section of Solar Pond Area

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 2a

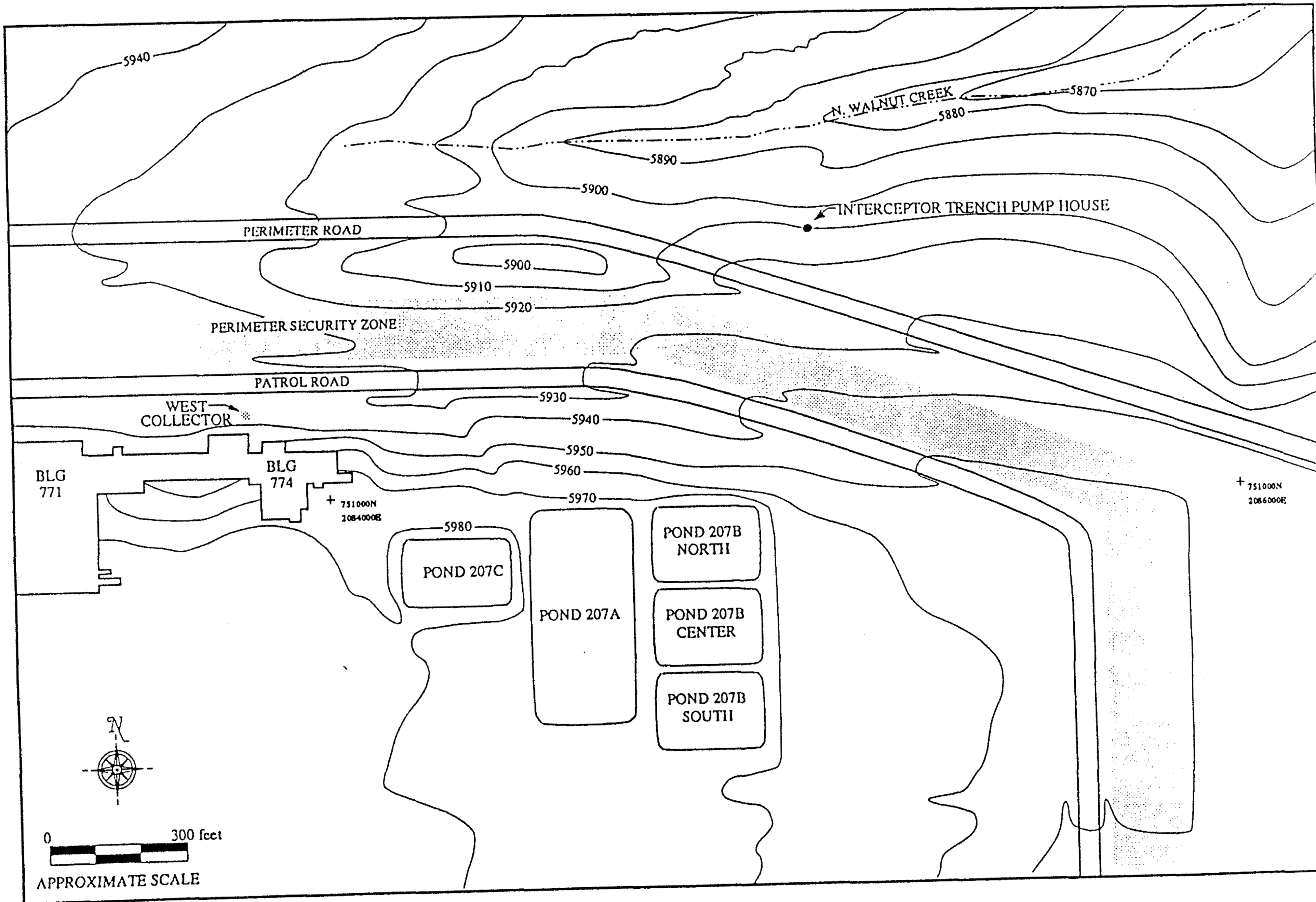


Cross Section of Solar Pond Area

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 2b

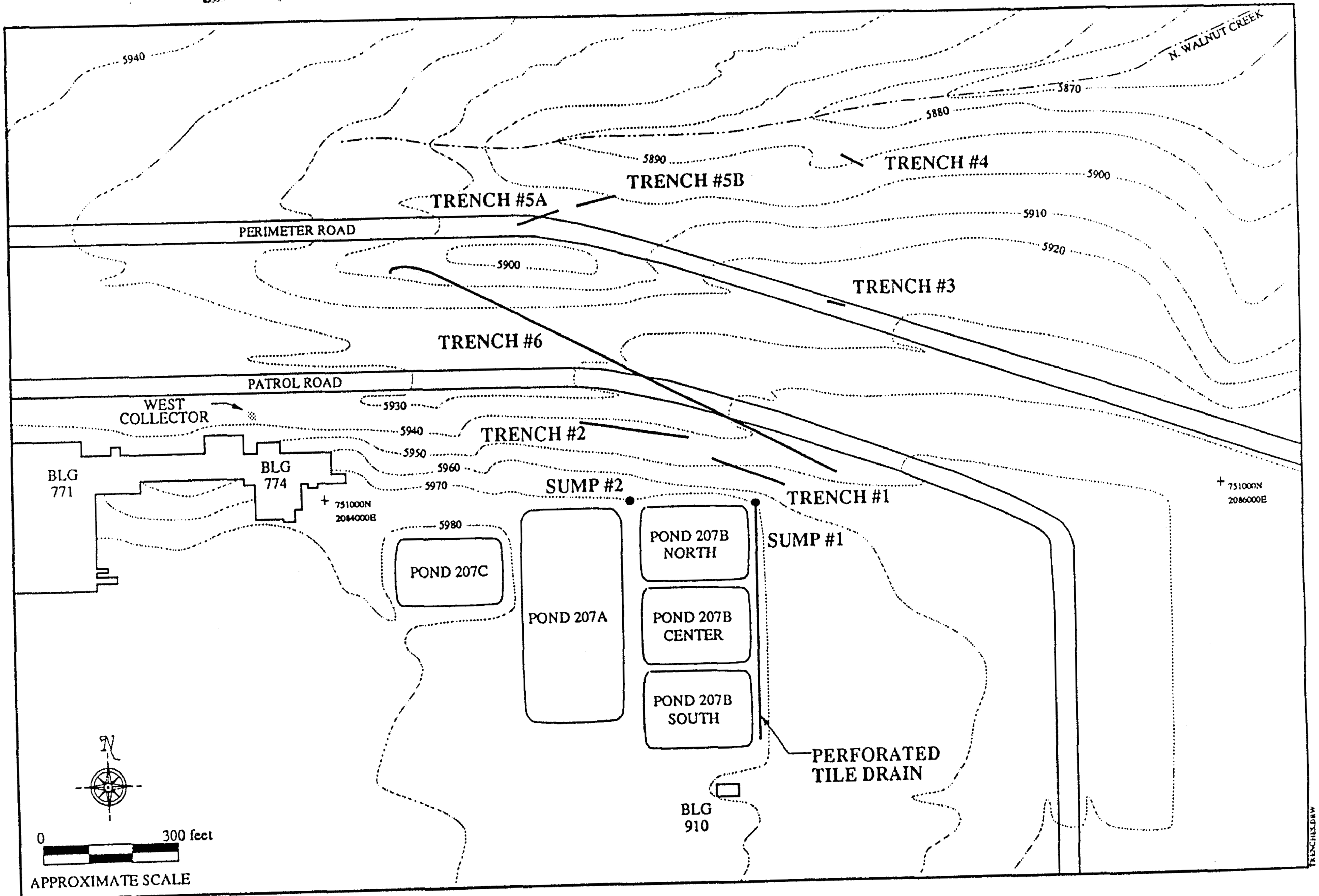


Solar Evaporation Ponds

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 3

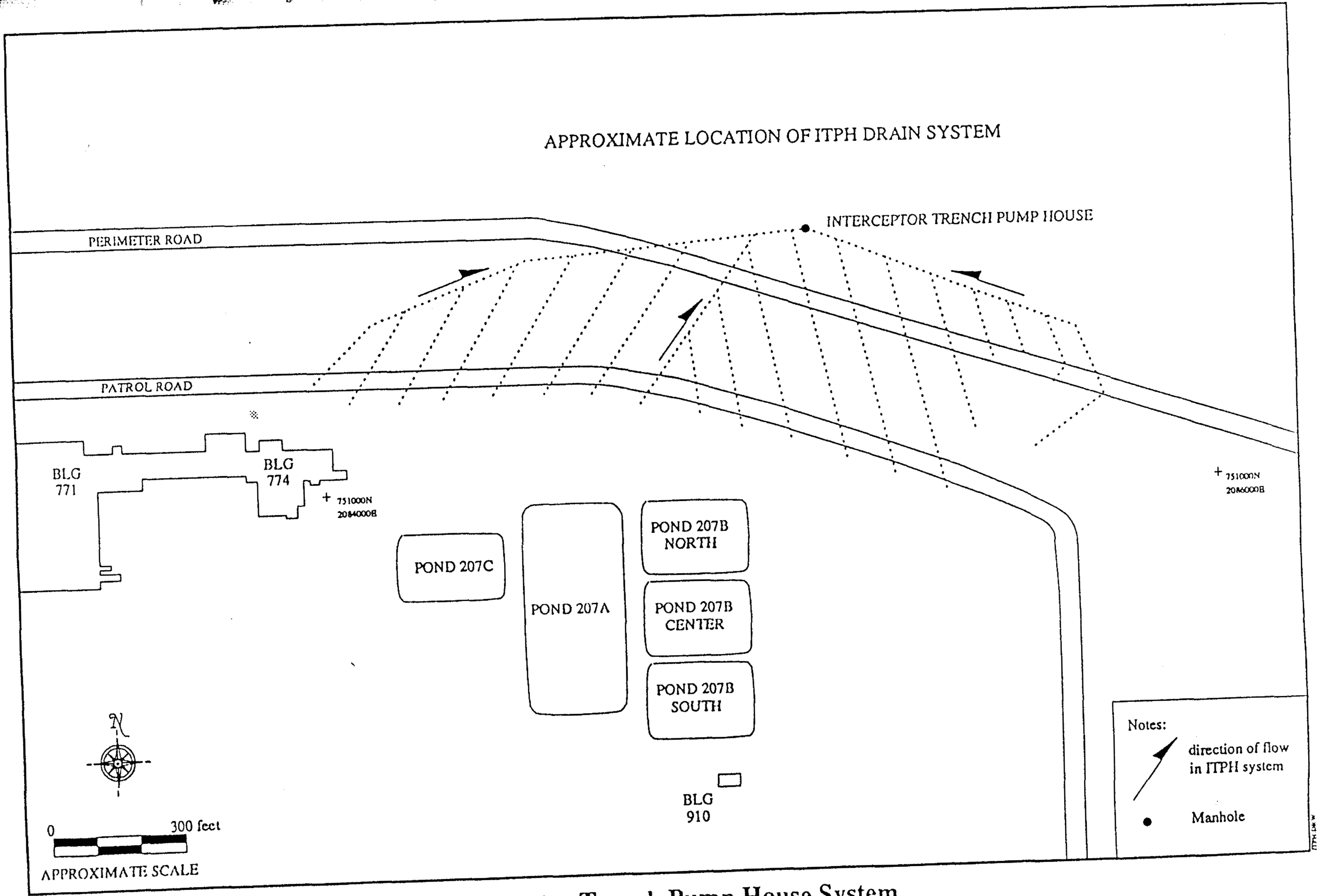


Trenches and Sumps

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 4

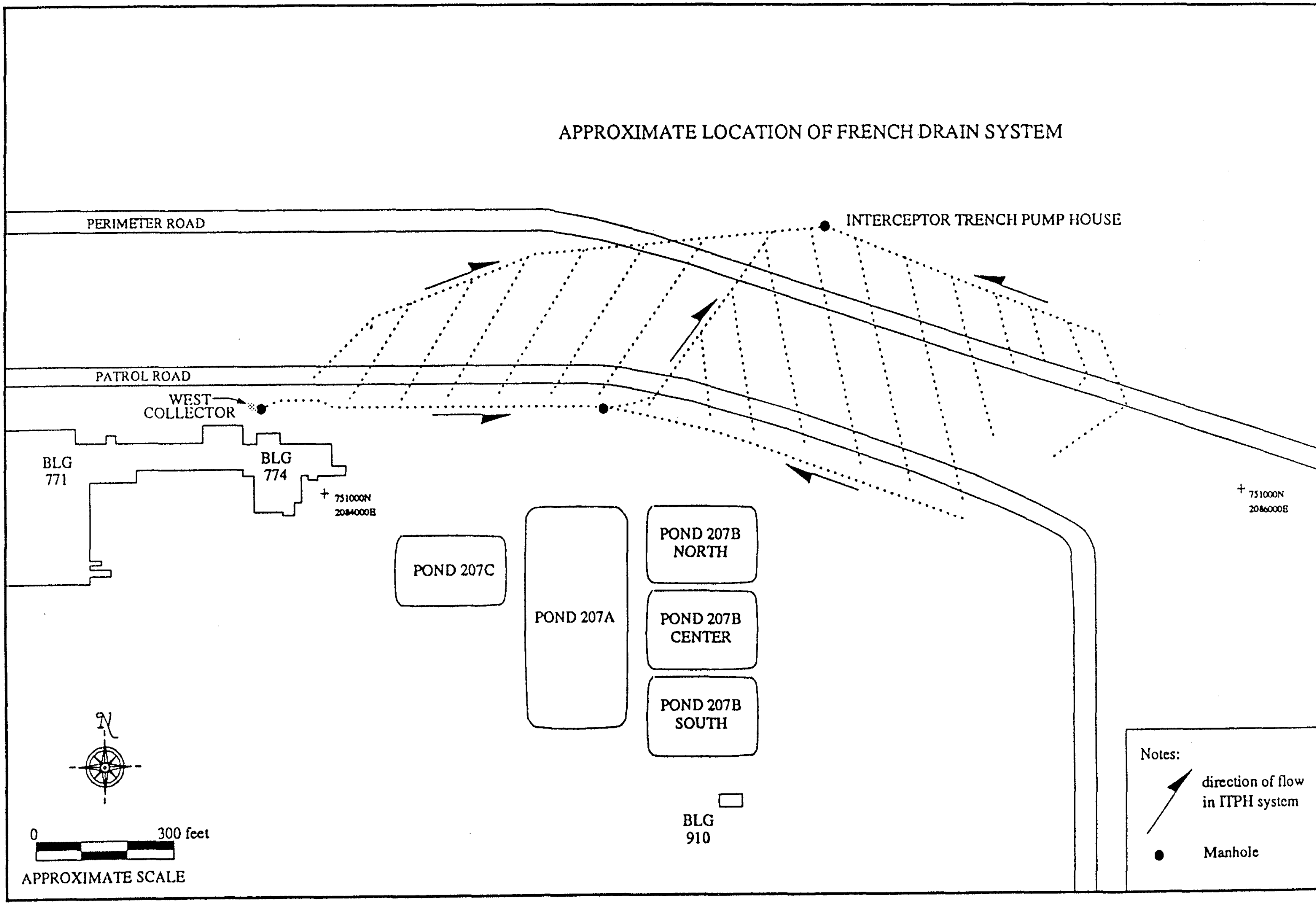


Interceptor Trench Pump House System

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 5

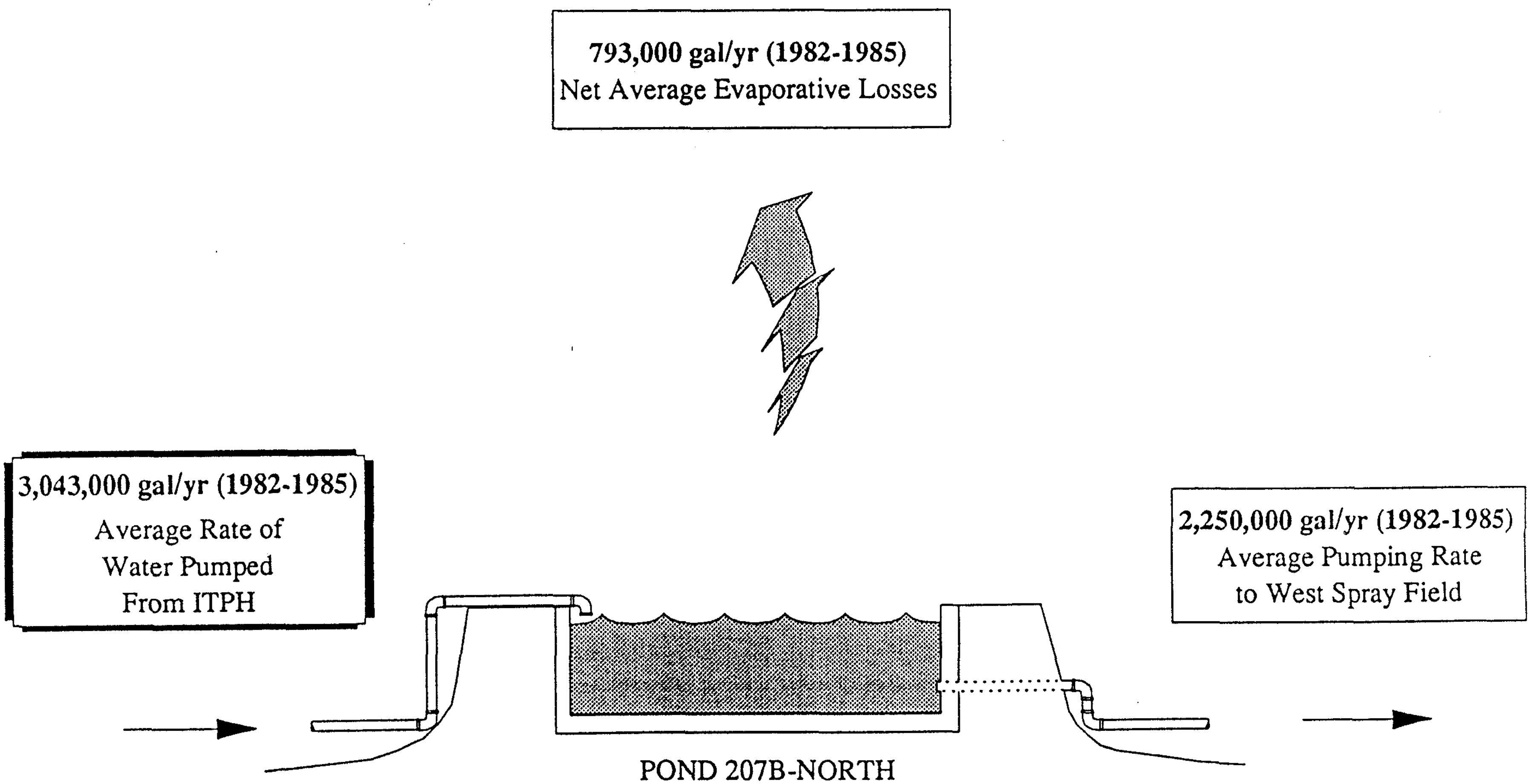


Interceptor Trench Pump House System With Extension

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 6



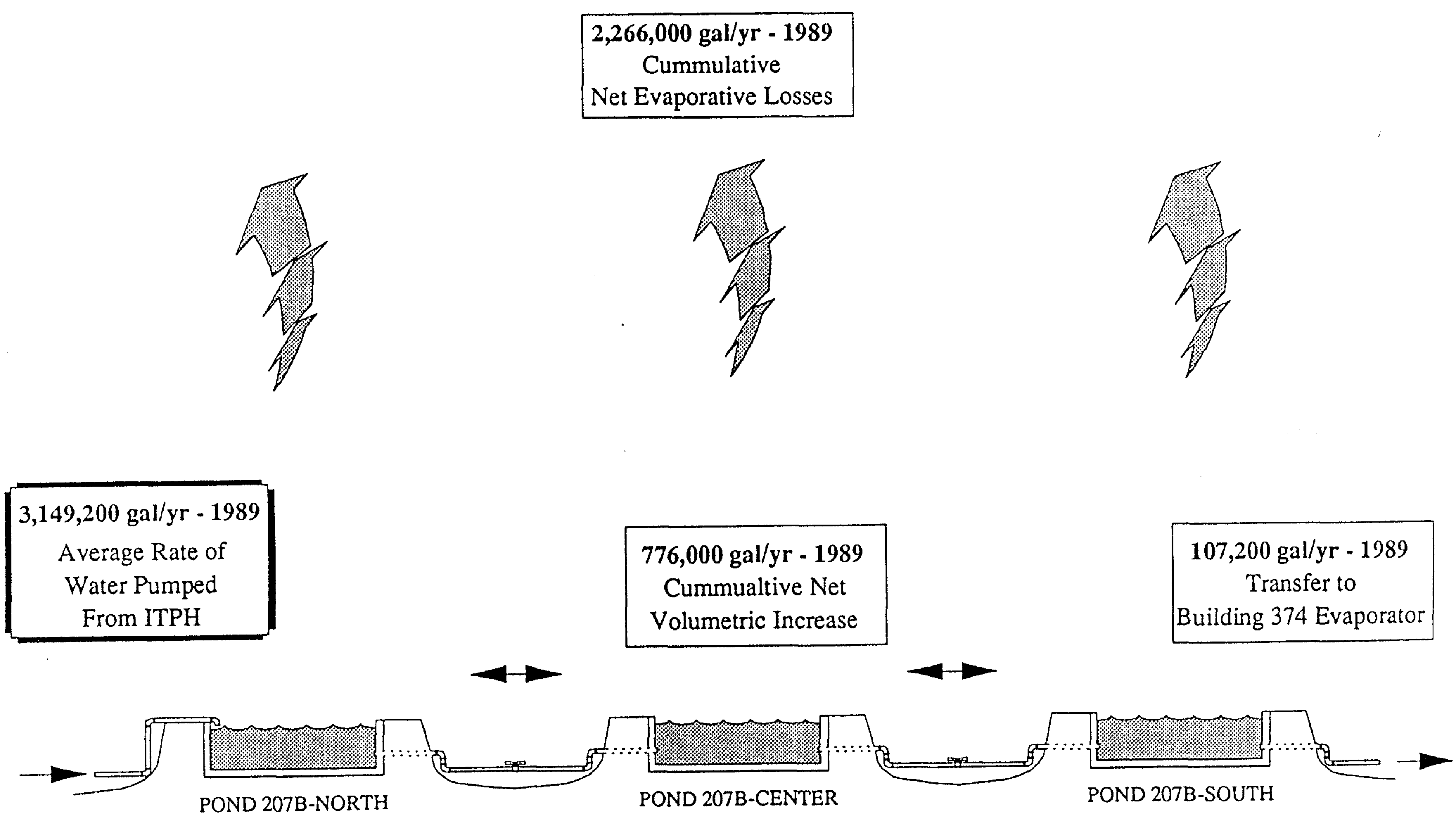
Note: During the period of 1982-1985, ITPH system water was returned to Pond 207B North and was pumped from the pond to the West Spray Field.

Schematic Average Water Balance (1982 - 1985)
Estimation Method #1

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 7



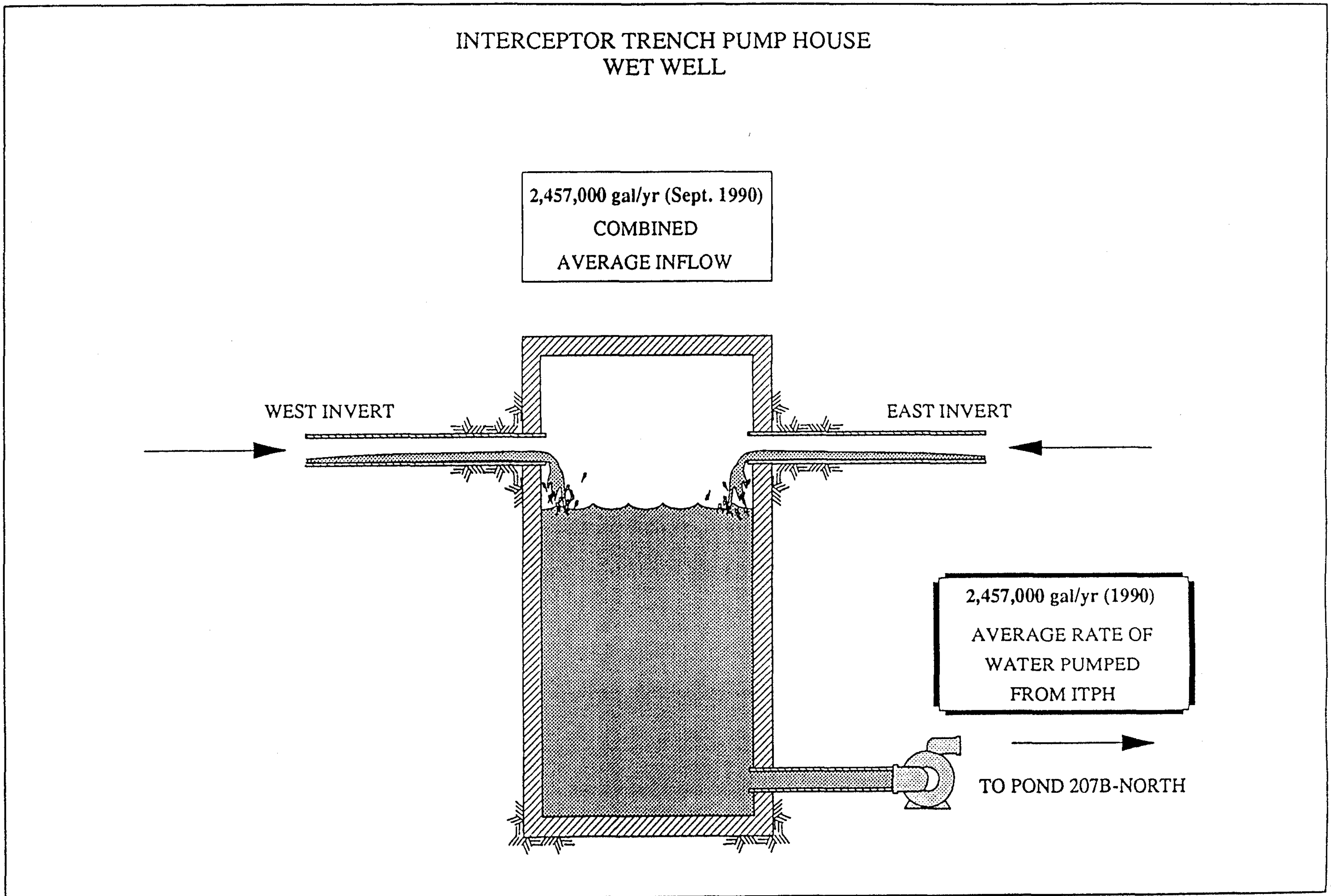
Note: During 1989, ITPH system water was returned to Pond 207B-North and was transferred to other solar ponds or to Building 374 for evaporation.

Schematic Average Water Balance (1989)
Estimation Method #2

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 8

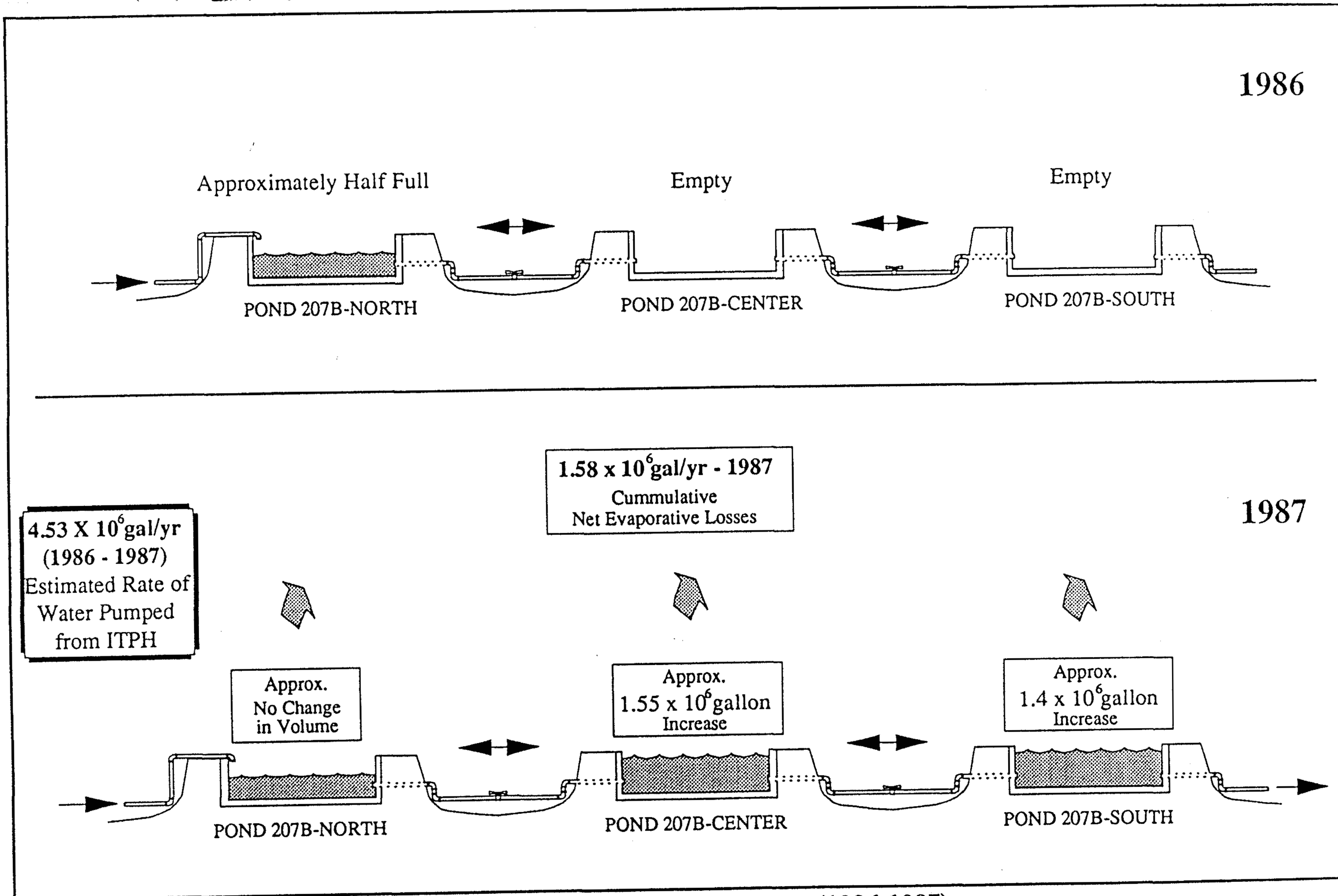


Schematic Average Water Balance (Sept. 1990)
Estimation Method #3

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 9

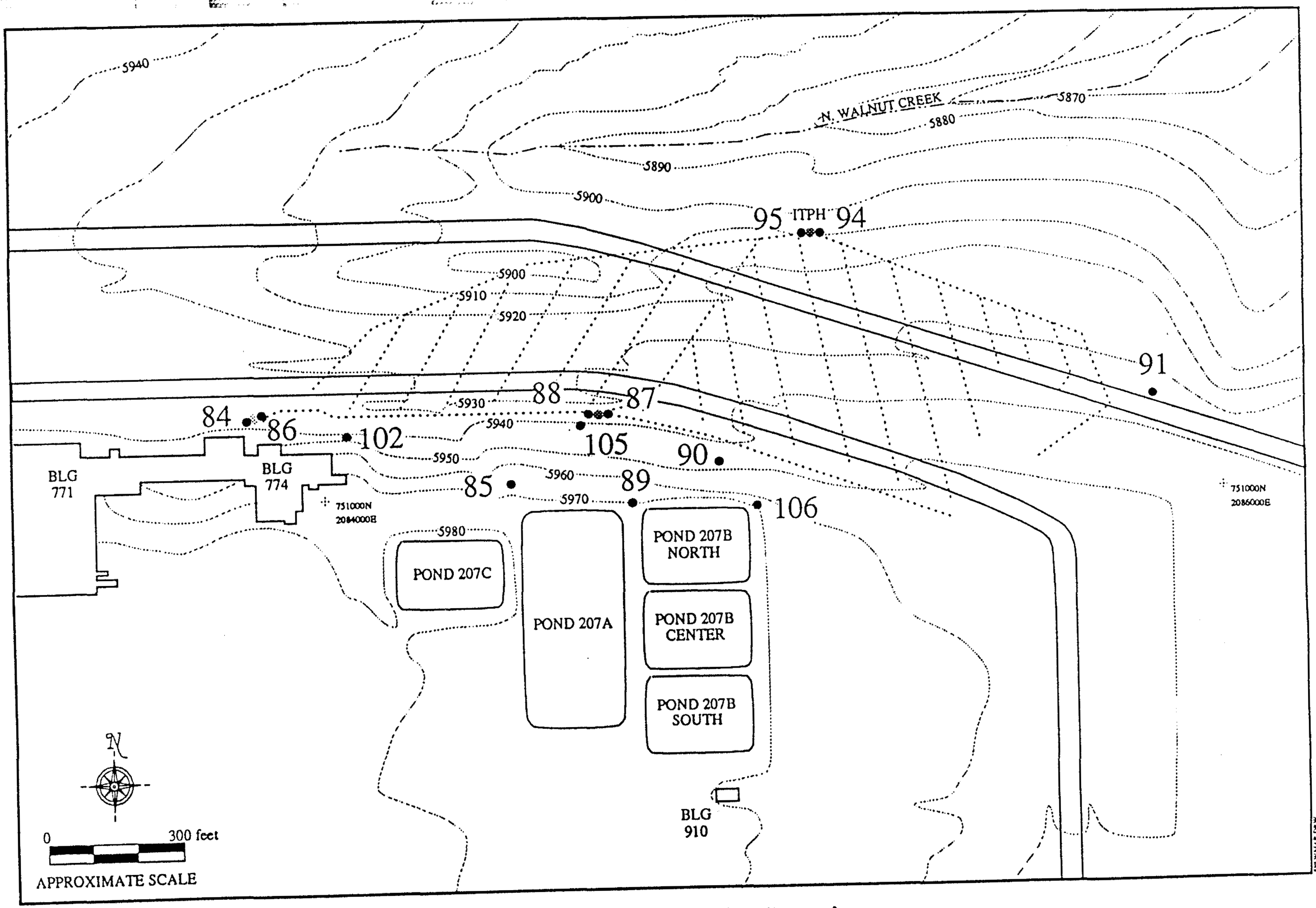


Schematic Average Water Balance (1986-1987)
Estimation Method #4

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 10

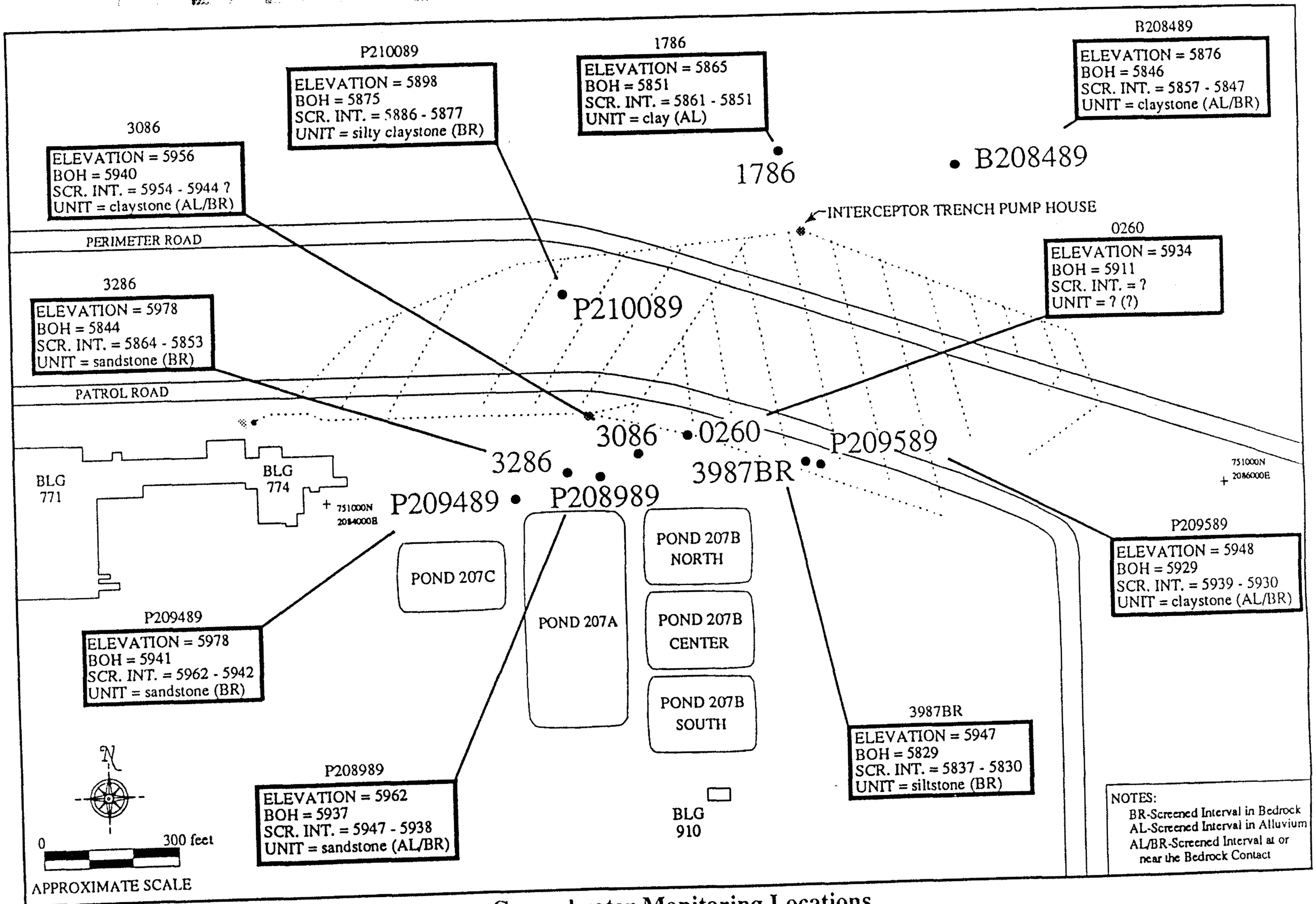


Surface Water Monitoring Locations

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 11

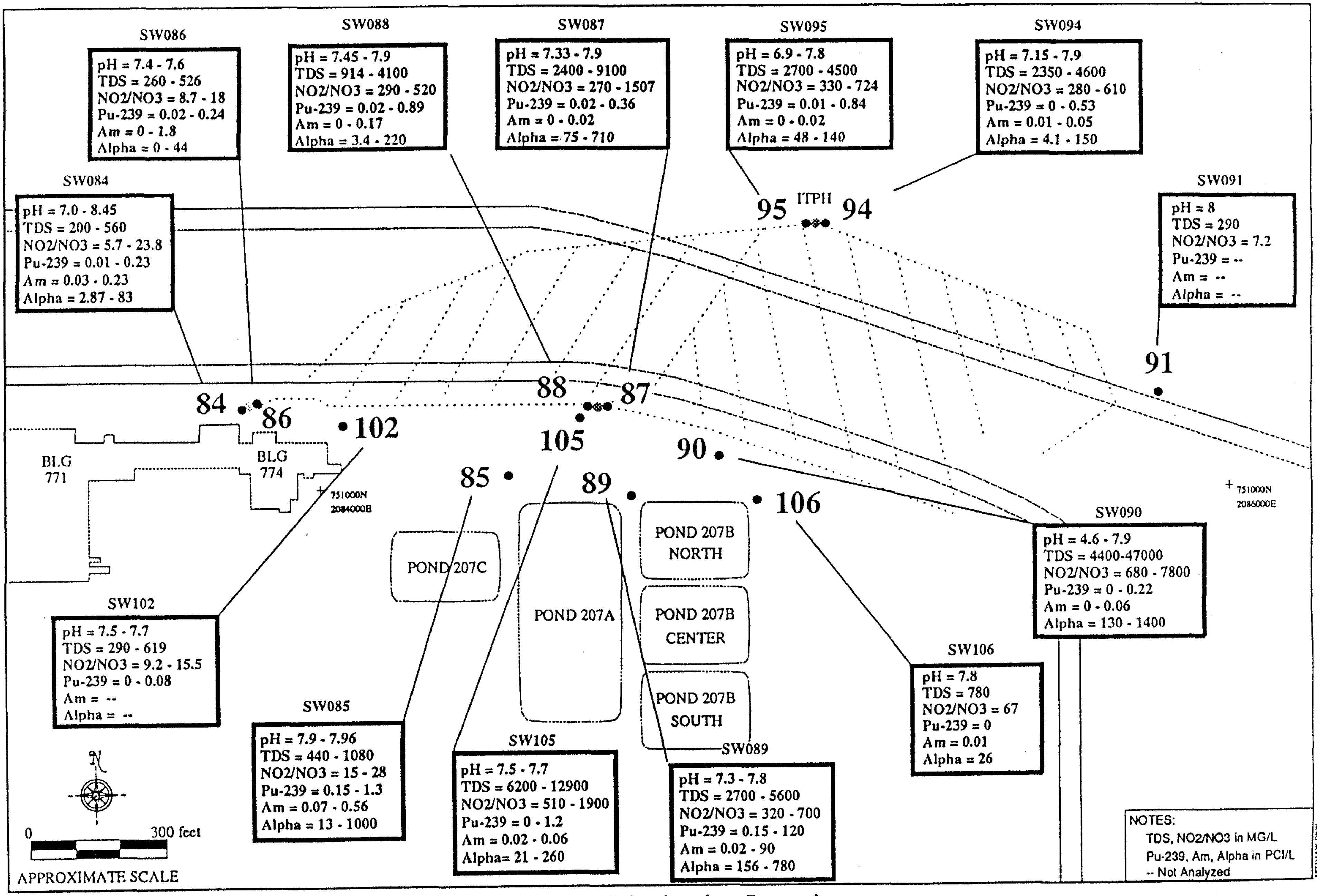


Groundwater Monitoring Locations
With Well Specifications

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 12

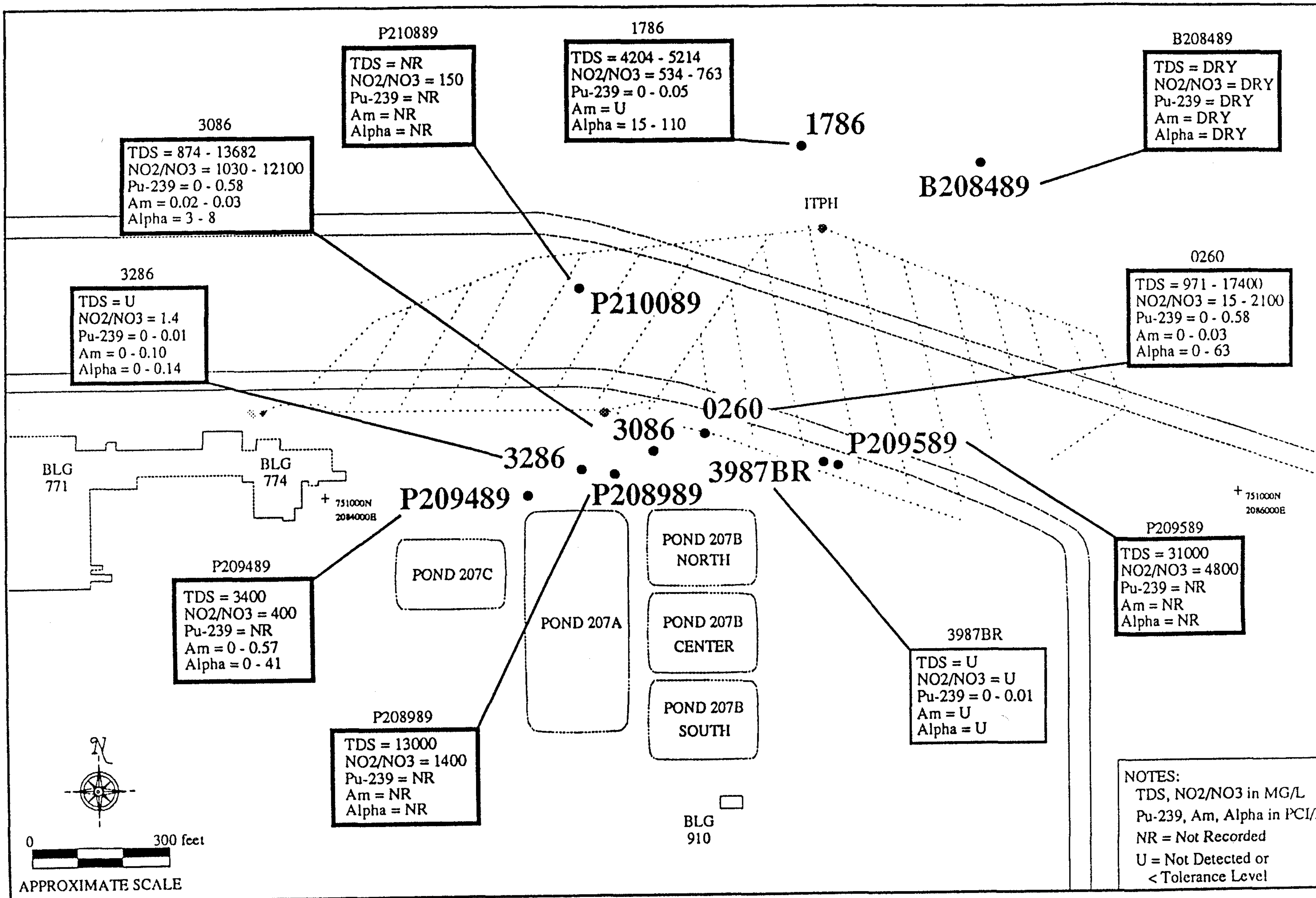


Surface Water Monitoring Locations
Indicating Concentrations of Selected Parameters

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 13

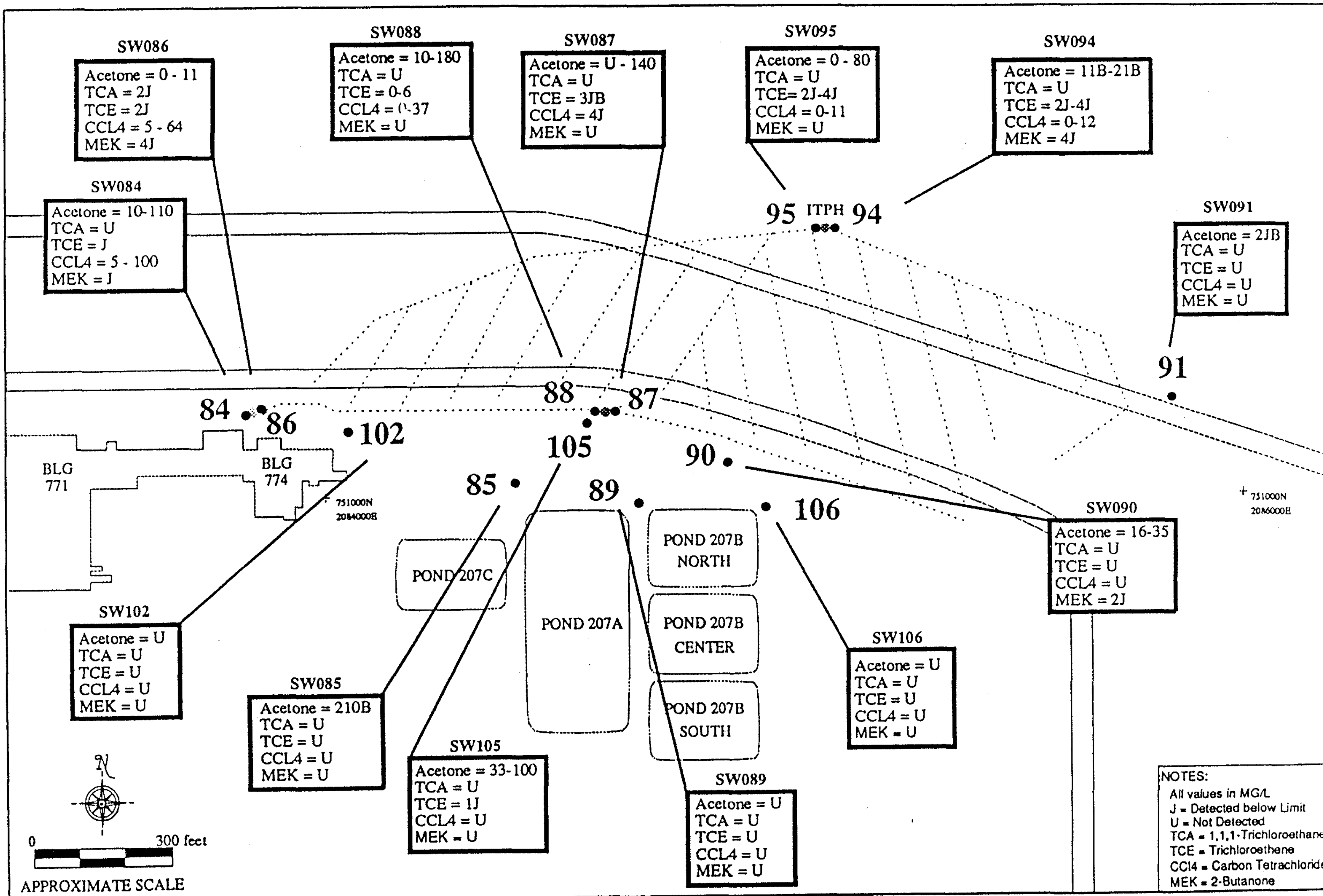


Ground Water Monitoring Locations
Indicating Concentrations of Selected Parameters

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 14

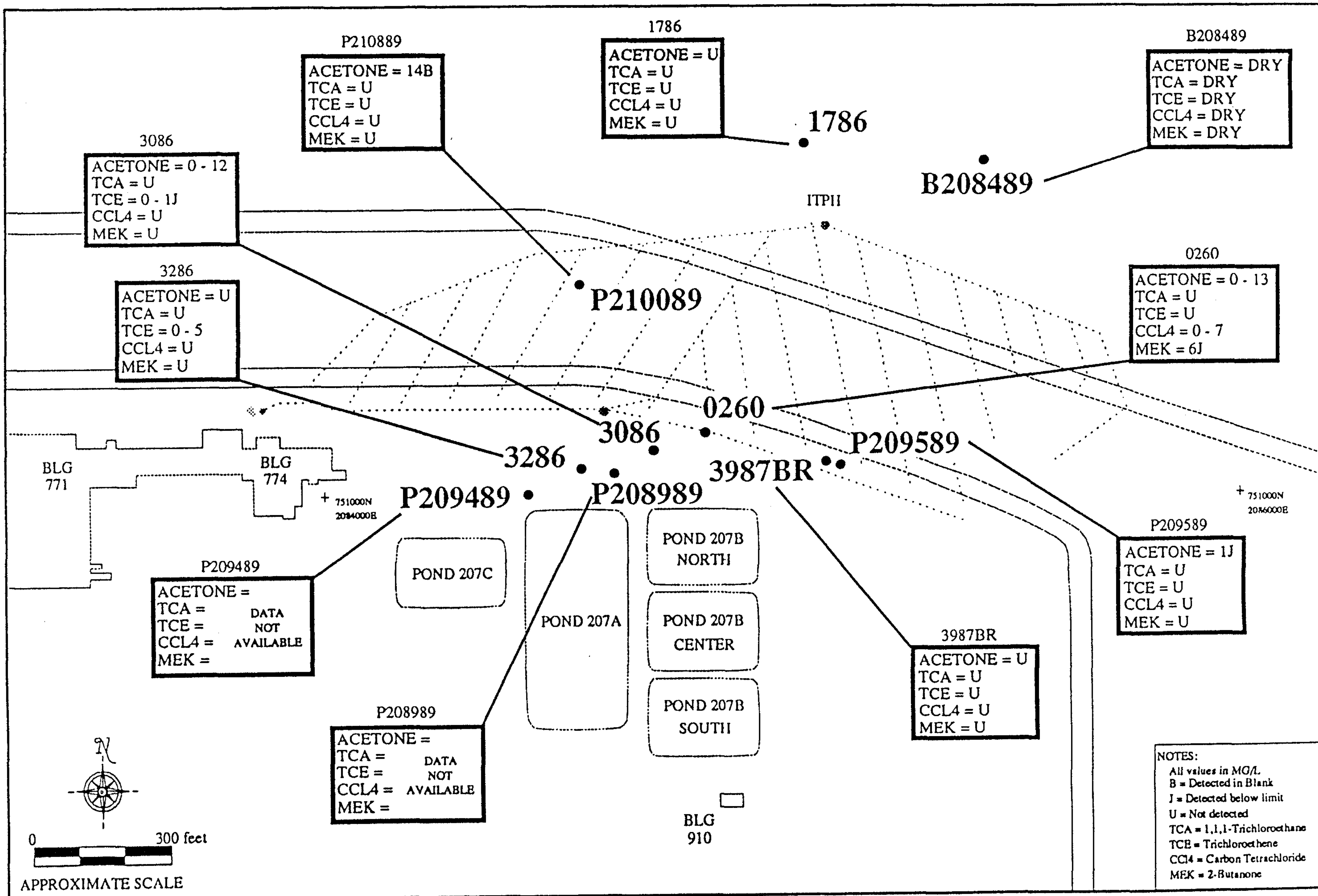


Surface Water Monitoring Locations
Indicating Concentrations of Selected VOCs

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 15

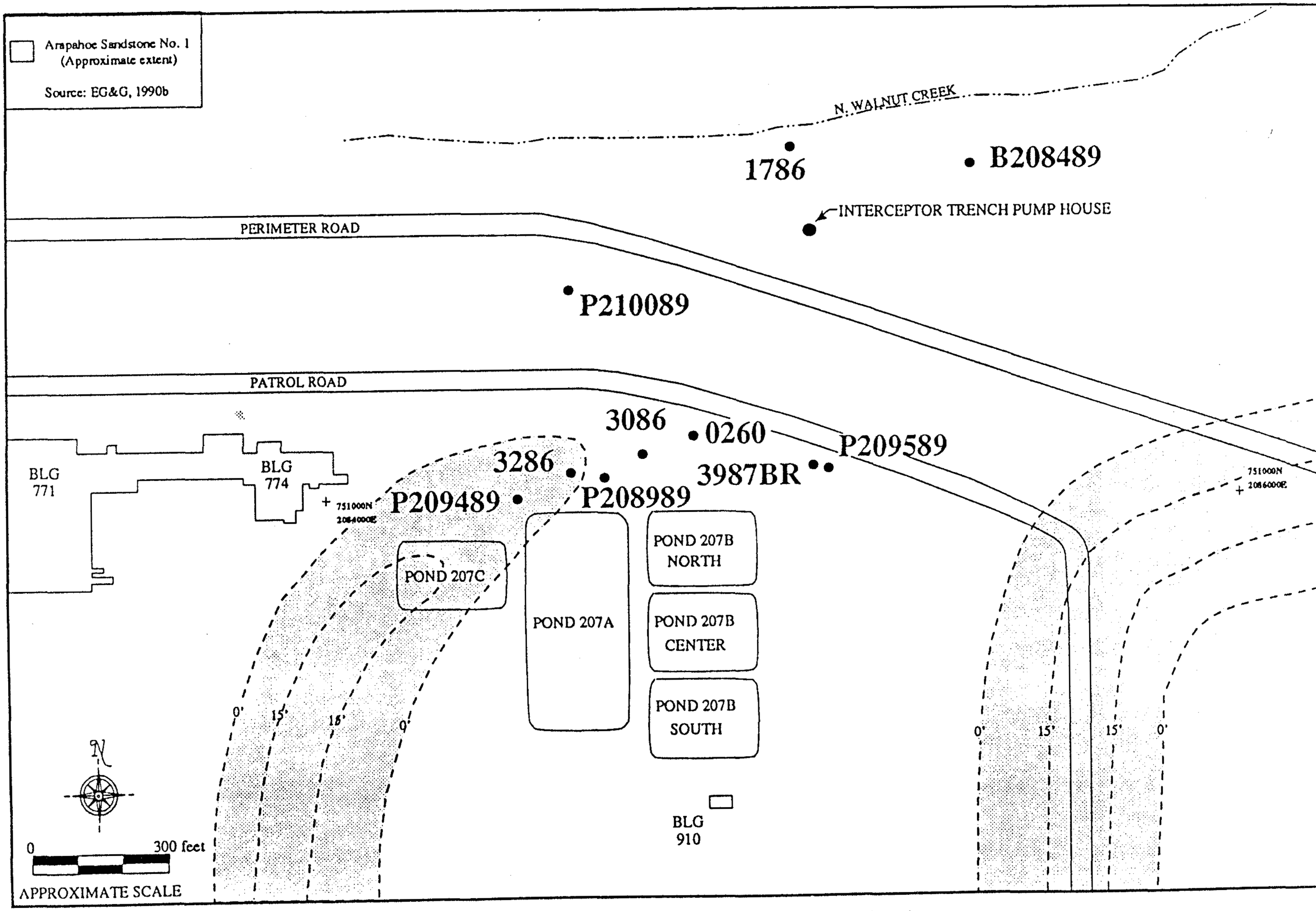


Groundwater Monitoring Locations Indicating Concentrations of Selected VOCs

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 16



Schematic Isopach Map of Sandstone No. 1

Solar Pond Interceptor Trench System
Groundwater Management Study
Zero-Offsite Water Discharge

PROJECT No. 208.0107

FIGURE No. 17

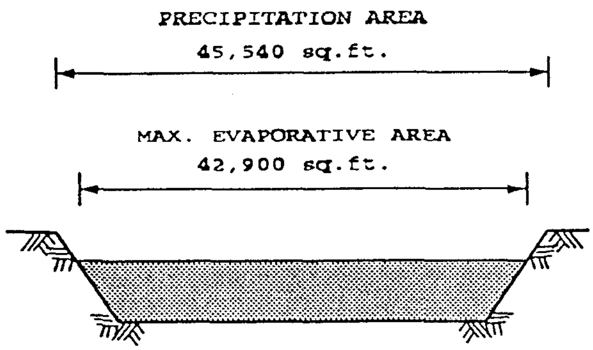
APPENDIX A

ANNUAL EVAPORATIVE LOSSES FROM SOLAR PONDS

APPENDIX A
ANNUAL EVAPORATIVE LOSSES FROM SOLAR PONDS

The solar ponds are in the process of being removed from service. Although total evaporation must be known, the important number for water balance calculations is the net evaporative number. The net evaporative number represents total evaporation offset by incident precipitation. The total area of precipitation collection by the solar ponds is slightly greater than the water surface area since all precipitation inside of the berms will be collected.

Solar Pond 207B effective areas:



Average Annual Precipitation for Rocky Flats Plant, 15.16" (based on 24-year precipitation record). Source: Rocky Flats Plant Site Environmental Report for 1988, January - December, 1988, RFP-ENV-88, May 1989.

Average Annual Evaporation for Denver Area: 45.75" (2.38 gallons/ft^2/month) 70% of Class A Pan Evaporation. See attached summary table. Source: Hazardous Waste Land Treatment Manual, SW-874, USEPA, Municipal Environmental Research Laboratory, Office of Research and Development, Cincinnati, Ohio, April 1983.

Average Net Annual Moisture Loss per Area: 30.59" (45.75" - 15.16")

Therefore, net evaporation losses per solar pond is approximately 1.6 gallons/ft^2/month

Net Evaporative Losses (Evaporation minus Precipitation) at the 207B Solar Ponds (accounting for area differences) are:

$$[(42{,}900\ ft^2 * (45.75/12)ft/yr) - (45{,}540\ ft^2 * (15.16/12)ft/yr)] * 7.48\ gallons/ft^3 =$$

$$(163{,}556\ ft^3/yr - 57{,}532\ ft^3/yr) *7.48\ gal/ft^3=$$

793,058 gallons/year or 1.54 gallons/ft^2/month (42,900 ft^2 area)

APPENDIX A
(continued)

APPROXIMATE PAN EVAPORATION IN DENVER
29 Year Record
1931 - 1960

MONTH	PAN EVAPORATION (cm)*
January	0
February	0
March	10
April	17
May	20
June	24
July	29
August	30
September	22
October	14
November	0
December	0
Annual Pan Evaporation	166 cm

(65.4 inches Annual Pan Evaporation)

Actual evaporation is approximately 0.7 of Pan Evaporation.* Therefore, actual evaporation is approximately 116 cm per year or 45.75 inches per year.

Note: A number of sources of information regarding total evaporation in the Rocky Flats area are available. These sources generally present total evaporation numbers that are different from other sources. These differences are due to a number of different reasons including varying lengths of data records. The number used in this report is on the high end of the typically reported numbers (greater total evaporation than normally reported). Any error introduced by this evaporation number should result in overestimation of total transferred flow. Overestimation of total flow may result in slightly over-sizing tanks and treatment trains which have fewer environmental consequences than undersizing tanks and treatment trains.

* Source: Hazardous Waste Land Treatment, SW-874, USEPA, Municipal Environmental Research Laboratory, Office of Research and Development, Cincinnati, Ohio, April 1983.

APPENDIX B

PUMP OUTPUT BASED ON 207B POND DEPTH READINGS

APPENDIX B

PUMP OUTPUT BASED ON 207B POND DEPTH READINGS

CUMULATIVE NET INCREASE IN 207B PONDS: **776,000 gal** March 1989-March 1990

(See Table B-1 for summary of monthly volumes)

EVAPORATION:

41.94 inches per pond March 1989 - March 1990
(NOAA Climatological Data Monthly Summaries March 1989 - March 1990, Ft. Collins Station Evaporation Data)

$(41.94 \text{ in/yr})(1 \text{ ft}/12 \text{ in})(42{,}900 \text{ ft}^2)(7.48 \text{ gal/ft}^3) = \mathbf{1{,}121{,}518 \text{ gal/pond}}$

Note: 207B ponds approximate evaporative area at 42,900 ft^2.

PRECIPITATION:

12.90 inches per pond March 1989 - March 1990
(RFP Precipitation Data - Meteorological Station)

$(12.90 \text{ in/yr})(1 \text{ ft}/12 \text{ in})(45{,}540 \text{ ft}^2)(7.48 \text{ gal/ft}^3) = \mathbf{366{,}187 \text{ gal/pond}}$

Note: 207B ponds approximate precipitation collection area at 45,540 ft^2.

NET EVAPORATION FOR 207B PONDS

3 x 1,121,518 = 3,364,554	Total Evaporation in 207B Ponds
- 3 x 355,187 = 1,098,561	Total Precipitation in 207B Ponds
2,265,993 gal	Net Evaporation in 207B Ponds

GROSS TRANSFER FROM 207B PONDS TO BUILDING 374:

107,218 gal March 1989 - March 1990

(Source: Building 374 Log Book)

APPENDIX B

PUMP OUTPUT BASED ON 207B POND DEPTH READINGS

TOTAL PUMP OUTPUT MARCH 1989 - MARCH 1990:

776,000	Net increase in Ponds
2,265,993	Net Evaporation
107,218	Gross Transfer to Building 374
3,149,211	Total Pump Output March 1989 - March 1990

TABLE B-1

MONTHLY VOLUMES OF WATER IN 207B PONDS
(GALLONS)

DATE	207B NORTH	207B CENTER	207B SOUTH	NET VOLUME FROM PUMPS	CUMUL-ATIVE TOTAL
March 1989	218956	-43012	-73679	102000	
April 1989	-54946	-84804	243894	104000	206000
May 1989	124029	-52475	143076	215000	421000
June 1989	-12773	439652	-68562	358000	779000
July 1989	63518	-179119	-158108	-274000	505000
Aug 1989	10516	23901	-150000	-116000	389000
Sept 1989	-39212	215525	-33335	143000	532000
Oct 1989	32757	-99862	161493	94000	626000
Nov 1989	66287	-109354	-129688	-173000	453000
Dec 1989	15837	9500	178274	204000	657000
Jan 1990	-50842	148763	-47	98000	755000
Feb 1990	-84294	55835	49841	21000	776000

APPENDIX C

RUNOFF CALCULATIONS
EXTENDED ITPH SYSTEM

APPENDIX C

RUNOFF CALCULATIONS - EXTENDED ITPH SYSTEM

Quantity of runoff is calculated by:

$$Q = CIA$$

where:

Q = Quantity of runoff
C = Runoff coefficient
I = Intensity of rainfall
A = Watershed Area

Runoff Coefficient (C):

The hillside north of the solar ponds is composed of relatively impermeable, steeply shaped, lightly vegetated soils. Runoff will therefore be greater than for many areas. According to Urban Drainage, the runoff coefficient for heavy industrial areas is approximately 0.80 (two year storm return frequency). This runoff coefficient will be applied to the watershed uphill of the ITPH extension. However, the ITPH extension graveled trench, which is 13 inches wide, has a different runoff coefficient. This runoff coefficient is estimated at 0.40, which is similar to the runoff coefficient for a sloped, gravel railroad yard given in Urban Drainage (two year storm return frequency).

Intensity of Rainfall (I):

Average Annual Precipitation for Rocky Flats Plant, 15.16" (based on 24-year precipitation record). Source: Rocky Flats Plant Site Environmental Report for 1988, January - December, 1988, RFP-ENV-88, May 1989.

Watershed Area (A):

Watershed Area east of ITPH Extension Manhole:
Approximately: 850 ft x 200 ft = 160,000 ft^2

Watershed Area west of ITPH Extension Manhole:
Approximately: 475 ft x 200 ft = 255,000 ft^2

APPENDIX C
(continued)

Total Annual Runoff from Watershed:

Areas east of ITPH extension manhole:

$Q = 0.80 * (15.16/12 \text{ ft/yr}) * 160{,}000 \text{ ft}^2 * 7.48 \text{ gal/ft}^3$
$= 1{,}209{,}566$ gallons/year

Areas west of ITPH extension manhole:

$Q = 0.80 * (15.16/12 \text{ ft/yr}) * 255{,}000 \text{ ft}^2 * 7.48 \text{ gal/ft}^3$
$= 1{,}927{,}746$ gallons/year

Total Runoff = 1,209,566 + 1,927,746 = 3,137,312 gallons/year

Amount of total runoff collected by ITPH Extension is that which does not flow past the ITPH Extension gravel trench. The amount of runoff that flows past the ITPH extension gravel trench is:

Area east of the ITPH extension manhole:

Q = 0.4 * 1,209,566 gallons/year = 483,826 gallons/year

Area west of the ITPH extension manhole:

Q = 0.4 * 1,927,746 gallons/year = 771,098 gallons/yr

Therefore, the amount collected by the ITPH extension gravel trench is:

Area east of the ITPH extension manhole:

1,209,566 - 483,826 = 725,740 gallons/year

Area west of the ITPH extension manhole:

1,927,746 - 771,098 = 1,156,648 gallons/year

APPENDIX C
(continued)

Total runoff collection by ITPH extension:

725,740 + 1,156,648 = 1,882,388 gallons/year

In summary, the ITPH extension may collect up to 1,882,388 gallons per year of stormwater runoff.

REFERENCE: Urban Storm Drainage Criteria Manual, Denver Regional Council of Governments, Urban Drainage and Flood Control District, March 1969, as amended and updated.

APPENDIX D

ITPH PUMP AND SYSTEM EVALUATION

APPENDIX D

ITPH PUMP AND SYSTEM EVALUATION

Pumps installed at pump station are Gorman-Rupp, self-priming, Model 82H2C-B pumps, running at 2900 RPM.

Motors are Sieman-Allis, 10 HP, Model No. 630, Frame 215T Motors running at 1745 RPM.

Water elevations in wet well:

Lead Pump On:	5862'-10" = 5862.83'
Lag Pump On:	5863'-10" = 5863.83'
Pump Off:	5860'-10" = 5860.83'
Force Main Outlet:	5973'-0" = 5973.00'

Therefore, static lift of system is:

Minimum:	5973.00' - 5863.83' = 109.17'
Typical Operating Average:	5973.00' - 5861.83' = 111.17'
Maximum:	5973.00' - 5860.83' = 112.17'

Force main is 3" diameter PVC pipe of approximate length of 760' of Force Main.

Intake is approximately 17' of 2" diameter PVC.

Minor losses of system are:

Item	Approx. Number	Pipe Diameter (inches)	Equivalent Length of Pipe	Total Equivalent Length
90° Elbows	4	2	5.17'	20.69'
90° Elbows	5	3	7.67'	38.35'
Check Valve	1	3	25.5'	25.5'
Tee, Branch flow	1	3	15.3'	15.3'

APPENDIX D
(continued)

Dynamic losses can be estimated by use of the following:

25 GPM

PVC Diameter (inches)	Total Equivalent (feet)	Head Loss (ft/100 ft of Pipe)	Total Head Loss in Pipe Length (feet)
2	37.68	1.28	0.482
3	839.15	0.225	1.89
2 x 3 Enlarger	-	-	0.03
2 Intake	-	-	0.083
3 Outlet	-	-	0.02
		Total Dynamic Head Loss:	2.5

50 GPM

PVC Diameter (inches)	Total Equivalent (feet)	Head Loss (ft/100 ft of Pipe)	Total Head Loss in Pipe Length (feet)
2	37.68	4.66	1.76
3	839.15	0.825	6.92
2 x 3 Enlarger	-	-	0.1
2 Intake	-	-	0.355
3 Outlet	-	-	0.08
		Total Dynamic Head Loss:	9.2

APPENDIX D
(continued)

75 GPM

PVC Diameter (inches)	Total Equivalent (feet)	Head Loss (ft/100 ft of Pipe)	Total Head Loss in Pipe Length (feet)
2	37.68	10.1	3.81
3	839.15	1.79	15.02
2 x 3 Enlarger	-	-	0.2
2 Intake	-	-	0.799
3 Outlet	-	-	0.18
		Total Dynamic Head Loss:	20

100 GPM

PVC Diameter (inches)	Total Equivalent (feet)	Head Loss (ft/100 ft of Pipe)	Total Head Loss in Pipe Length (feet)
2	37.68	17.5	6.59
3	839.15	3.12	26.18
2 x 3 Enlarger	-	-	0.4
2 Intake	-	-	1.42
3 Outlet	-	-	0.32
		Total Dynamic Head Loss:	34.9

APPENDIX D
(continued)

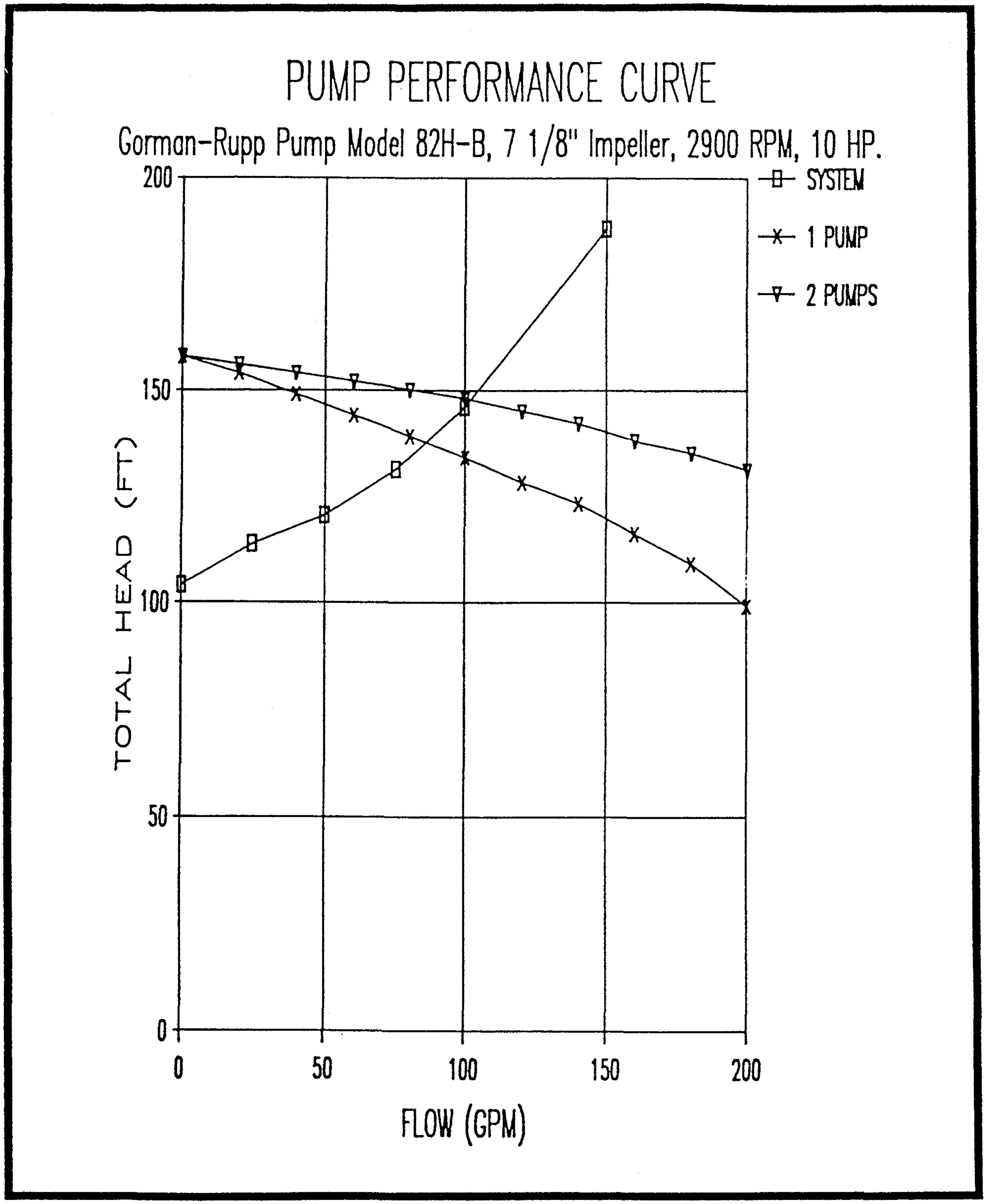
150 GPM

PVC Diameter (inches)	Total Equivalent (feet)	Head Loss (ft/100 ft of Pipe)	Total Head Loss in Pipe Length (feet)
2	37.68	38.4	14.47
3	839.15	6.87	57.65
2 x 3 Enlarger	-	-	0.91
2 Intake	-	-	3.20
3 Outlet	-	-	0.72
		Total Dynamic Head Loss:	76.9

In summary:

Flow (GPM)	Total Dynamic Losses	Average* System Loss (ft)
25	2.5	113.67
50	9.2	120.37
75	20.0	131.17
100	34.9	146.07
150	76.9	188.07

* Differences in minimum and maximum static lift are negligible.


PUMP PERFORMANCE CURVE
Gorman-Rupp Pump Model 82H-B, 7 1/8" Impeller, 2900 RPM, 10 HP.
SYSTEM
1 PUMP
2 PUMPS
TOTAL HEAD (FT)
200
150
100
50
0
0
50
100
150
200
FLOW (GPM)